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THE TRUE MEANING OF THE OPEN SHOP.

AN EXPLANATION OF THE PROPOSED CAMPAIGN OF EDUCATION.

By James W. Van Cleave, President of the National Association of Manufacturers.

Mr. Van Cleave's article is written in response to an invitation extended to him by the editors of THE ENGINEERING MAGAZINE a few days after his re-election as president of the National Association of Manufacturers, at its annual convention lately held in New York. Following closely upon the much-noted agreement reached in the British engineering trades, the significant action taken at this convention constituted one of the most important events in current industrial history, but it did not seem to be clearly enough comprehended by the daily press or the public to prevent misunderstanding of the principles it was proposed to advance. The occasion appeared to us opportune for a clear explanation of the stand for the open shop, which is the characteristic plank in the platform drawn at New York, and of the full scope of the campaign in which the Association confidently appeals for the sympathy and approval of the manufacturing world. We are glad indeed, through Mr. Van Cleave's distinguished co-operation, to present so able, authoritative, and appealing a statement of the ideals which underlie this newest and most potentially powerful movement in the economics of American industry.—THE EDITORS.

THE invitation extended to me to prepare this article states concisely the argument for its appearance. There is much misunderstanding by the daily newspapers regarding the "significant action" taken by the National Association of Manufacturers, and especially concerning "the principles which the great fund proposed for the Association was designed to advance." In availing myself of the opportunity to correct this misunderstanding, I cannot begin better than by giving the platform of the Association, which was first formulated in our annual convention of 1903, which has been sanctioned every year, and which may be broadly outlined thus:

1. The open shop.

2. No restrictions as to the use of tools, machinery or materials, except as to such as are unsafe.

3. No limitation of output.

4. No restriction as to the number of apprentices and helpers, when of proper age.

5. No boycott.

6. No sympathetic strike.

7. No sacrifice of the independent workingman to the labor union.

8. No compulsory use of the union label.

The Association, at its convention of May 22, resolved to "instruct its officers to establish and finance a Council to serve as a means of harmonizing and federating the various National and State organiztions of citizens, merchants and employers, to the end of utilizing them in a vigorous educational campaign in the interest of industrial peace and mutual good will." I told the convention that I thought that $500,000 a year, or thereabouts, for three years, would be needed to make the work of the proposed council effective. This suggestion received the convention's unanimous approval.

Here is where some of the newspapers erred in interpreting the purpose. They said the $1,500,000 was intended as a war fund by which we aimed to crush the labor unions. Nothing was farther from my thoughts. And I think I am safe in saying that such a thing did not enter the thoughts of any member of the Association which adopted this programme. To show the absurdity of this interpretention of my attitude toward the labor unions, I here give a few extracts from addresses by me in Chicago, Boston, Washington and New York on various occasions in the past few months:

> "Originally the labor unions were called into being by the oppression of some of the employers. In several ways they have done good service to the workers. They have prompted a fraternal feeling and have cultivated a spirit of mutual helpfulness between men in many sorts of occupations. They have aided in advancing the wages of the workers, and thus have obtained for labor a large share of the profits which the co-operation of labor and capital have brought. As fair-minded men we must concede all this. I, for one, have certainly no desire to take away any of the credit belonging to any of the labor unions for any good of any kind which any of them have done."
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> "We must recognize the good which is in labor unionism as well as the evil. We must not condemn all the labor unions for the offenses

of some of them, any more than we would like to have all employers blamed for the shortcomings of a few."

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"As an ally in combating the extremists who would revolutionize society, abolish the principal incentives for individual exertion, and assail the individual's property and social rights, all good citizens should welcome such co-operation as the labor unions give us. For this reason the employer who would like to strike down all the labor unions indiscriminately is blind to his own interests as well as faithless to his duty to the general public."

Every one of those expressions I repeat emphatically here, and now. In answer to the charge of several papers that I am trying to incite a "war between classes," I here quote a few words from one of my recent addresses in Chicago:

"The principle upon which the United States Government is founded is equality of privileges and duties for all. Our aim should be to bring employer and employee into fraternal co-operation. Each is necessary to the welfare of the other. If the worker is discontented his usefulness to his employer is diminished, and that employer's interests, social and financial, suffer. The more cordial the feeling which each holds for the other the better for each and for society. The strife between classes and orders which has disturbed Europe for centuries has no place in the social economy of democratic America."

This sentiment I reiterate here. The National Association of Manufacturers, which is itself the largest coalition of employers in the country, asks for a federation of the various organizations of employers throughout the United States for these reasons, chiefly:

1. Defence of our common interests.
2. Political and legislative work.
3. Legal work.
4. The establishment of labor bureaus.
5. Additional organization work.
6. Publicity and education.

In our plan of a federation of all the associations of citizens, merchants and employers of labor in every field, National and State, each organization, while preserving its independence as absolutely as at present, will come into co-operation with all the other organizations in a great council, in which each will have a voice, and in which all will meet on terms of fraternity and equality. Each organization, as now, will deal with the issues affecting itself solely, and the federation, through its council, will handle all the concerns common to all the associations. These concerns are not only large in magnitude but they

are large in number. And in number as well as in magnitude they are rapidly expanding. All the organizations represented in the council will go promptly to the defence of any of its members which need assistance. But in order to command this aid the member assailed must be fighting for a principle favored by the council, and be fighting by methods and with weapons which the council recognizes to be just.

The federation's political activity will not be swayed in the slightest degree by party considerations. Many members of Congress and of the legislatures, while honest and conscientious, are timid in dealing with some of the public questions. They are afraid of labor-union assaults at the polls, and in some cases this fear is well founded. When those men represent true Americanism, as did Littlefield of Maine and other congressmen in many states who were attacked by the labor unions in the campaign of 1906, our federation, in the interest of good citizenship, will support them through our literary bureau, on the stump and at the polls.

Littlefield was a Republican, and so were some of the other congressmen who were attacked by the labor unions in 1906 for legislating in the interest of the American people instead of in the interest of the minute fragment of the people comprised in the labor societies. That, however, is a detail in which we would have no concern. Such tags as "Republican" or "Democrat," we will, in our political work, entirely disregard. We will stand up for stalwart Americanism wherever we see it. When we do not see it we will endeavor to create it.

In each State we propose to have a carefully selected committee to look after local legislation in the interest of industry and progress. These committees will report to the council, and will work under the council's direction. We will have National committees, in which all sections and all associations and interests will be represented, to concern themselves with the great questions before Congress, or which ought to be placed before Congress. No lobbying, however, will be done by us at any of the State capitals or at the capital of the nation. All improper political methods will not only be shunned by us, but will be assailed by us when employed by others. But every legitimate weapon on which we can lay our hands, through out business, social, and personal connections and affiliations throughout the United States, will be wielded to defeat bad legislation and to promote good legislation.

Under the direction of the council will be a corps of skilled lawyers who will advise local organizations on all legal questions, will report

the violation of all State and National laws affecting industry and trade, and, if necessary, will aid the States and the National Government in the prosecution of all offenders against these statutes. An important part of that corps' work will be the prosecution of all labor-union boycotters, picketers, or participants in any assaults on workers, or in any acts of intimidation or coercion.

As shortages and surpluses of labor may exist simultaneously in different localities, we will create labor bureaus in all the country's important industrial centers, and through them the council can operate a labor clearing house by which all such abnormalities can be corrected and a balance established. Through these labor bureaus the council could look after the better distribution of immigrants in the regions in which the chances for their employment are greatest. It could also, through these bureaus, secure picked labor in Europe, so far as this can be accomplished under the immigration regulations and restrictions which go into operation on July 1, 1907, and direct it to the proper localities.

Our ultimate and permanent dependence for skilled labor, however, is in the American boy. This is a fact which I have emphasized in many addresses and in many connections. We must attach a manual-training department to all our public schools of the primary grade, in which boys of 9 or 10 years of age and upward, under competent instructors, can give an hour each day to the use of the tools employed in the more important mechanical trades. This instruction must be free, and should be compulsory. We must have industrial high schools, also free, into which boys of 14 or 15 who have taken the course in the primary schools may enter for advanced and practical instruction, and from which they can be graduated as thorough mechanics. The object of this manual training in the public schools is to supply the need created by the labor unions' virtual abolition of the apprenticeship system, and to supply it in the best possible way and with the best possible material. All the influence of the federation must be used to equip our American boys with a thorough industrial training.

By means of our coalition of all the associations of employers of labor and of all the societies for the cultivation and the extension of good citizenship in the United States, we will raise up a vast body of earnest, public-spirited workers, who will be available in combating every bad issue and cause, and in championing every cause which is calculated to advance the country's prosperity and influence. Knowing that organization for worthy objects incites courage, confidence

and enthusiasm, our aim is to extend our organization to the farthest possible extent throughout the country, to cultivate high ideals among our members, and to promote those ideals with all the resources which we can command.

Our principal weapon in all our work will be education and publicity. Let me refer here to something which I said on this point in an address a few months ago.

> "We must, through books, newspapers and public addresses, educate the people, employers and employees alike, and show them their duties as members of society. We must curb the greed of the autocratic employer, point out to the worker that his interest lies in rendering a fair day's service for a fair day's wage, prove that the true relations between capital and labor are those of fraternity and not of war, and that the same incentive for right conduct and the same punishment for wrongdoing presents itself to rich and poor alike. In this way we will diminish strikes and lock-outs, remove all desire on the part of workers for the enactment of anti-injunction laws, and establish an era of industrial peace throughout the country."

These words are taken from an address which I delivered in Chicago recently at the annual convention of the Citizens' Industrial Association of America, of which I am an officer, and of which I was one of the founders. They expressed my idea of the work which, as a national organization, the Citizens' Industrial Association ought to do, and which, in its field, it is endeavoring to do. The St. Louis branch of the Association, of which I am president, has been working along these lines for several years, with very gratifying success.

The work which the Citizens' Industrial Association has been doing in an educational way, and which is being done in a larger field by the National Association of Manufacturers, will be done with far greater resources and on an immeasurably more extensive scale by the federation of organizations of employers and of citizens which we are engaged in forming. Of this federation the National Association of Manufacturers will be the largest member and the nucleus. With us in this federation we expect to get the Citizens' Industrial Association, the Founders, the Metal Trades, the Typothetæ, the Lithographers, and all the rest of the great national organizations of employers and of citizens, and most of the State organizations. For educational purposes—for the education of the employer and the worker alike—we are raising the fund which has aroused the distrust of some of the newspapers.

It will be noticed that I have used the words "industrial peace" in many places in this article. I have done this because the words ex-

press, with precision, our purpose in forming the federation, and in raising the fund through which the federation will do its work. The words are not employed by me in any ironical or sinister sense. We are not proposing to create a solitude and call it peace. Nor do we, as a preliminary to an attack on the labor unions, cry peace, peace, when there is no peace. As I use the word peace in this article and in the other connections in which I have employed it, the word carries the plain American meaning which will be found in any of our dictionaries, without any reservations, qualifications or emendations of any sort.

I wish to call the attention of our good friends of the daily press to what I have just said, and to what I am about to say. The federation and its fund will work for peace and not for war. I wish also to call their attention to the fact that the resolution of the convention of the National Association of Manufacturers which declared in favor of the federation expressly set forth that the federation and the fund which would finance it are for the purpose of making a "vigorous educational campaign," and for making it "in the interest of righteous industrial peace and of mutual good will."

The peace which will produce "good will" between employers and workers must necessarily be "righteous." No other kind of a peace would satisfy both sides. No other sort of a peace would stick. We seek a peace which will be permanent. If possible, we want to do the work of peace-making so well in 1907, 1908, or 1909 that neither we nor any of our successors will find it necessary to do the work over again in 1910, 1915, or ever.

We have selfish as well as moral reasons for wanting industrial peace. The moral reasons appeal to all good citizens alike—to all who love their fellow men, and who wish to see their country made prosperous and powerful. The selfish reasons appeal to us as business men who want stability in the labor market, who want to be able to make contracts with our workers which will last, who want to lengthen the country's lead in the great industrial activities, and who aim to equip ourselves to meet the competition which our European rivals are putting up for us in the markets of the world.

Our propaganda will not be against labor unionism as such, but against the vicious practices which have fastened themselves on some of the unions—the practices which embody themselves in the public mind when the names of such leaders as Sam Parks, Debs, Martin Irons, Shea, and Schmitz are mentioned. In this age of concentration and consolidation in all activities, industrial and social, the workers

have as good a right to organize as have the employers. A majority of the members of the labor unions are good men. Some of them are among the worthiest of the country's citizens.

In our campaign of education we will aim to strengthen the hands of these members of the unions, so that they can overthrow such corrupt and incapable officers as they may have, and replace them by conservative and progressive men. Our work will be carried on among the employers also. We are against industrial oppressions, regardless of whether the oppressors are employers or employees. Monopoly of all sorts, in the form of capitalistic trusts as well as of labor trusts, we will combat.

Believing, with Jefferson, that error is never dangerous so long as truth is free to combat it, and has at the same time the spirit and the facilities to combat it, we will fight ignorance with education, narrowness and blindness with enlightenment. We will fight demagogism, socialism, anarchism and all things that pretend that the rich are the enemies of the poor, that seek to establish class lines and incite class hatreds in the community, and that raise their hands against the Government and the social order.

Under the direction of the council, in which all our organization, National and State, will have a voice, and which will order and supervise all the Federation's activities, we will have a literary bureau and corps of writers and lecturers. These persons, men and women, will be selected with regard to their education and their fitness for the particular tasks to which they are assigned, as well as with regard to their zeal for their work, and their determination to make it effective.

We propose to shape our instruction to the environment, the capacity, and the prejudices of the elements which are to be reached. Through the regular daily and weekly papers and the magazines, through our own publications, and from the platform and the pulpit, we shall preach the gospel of peace between rich and poor, between capital and labor, between employer and worker. In this way we will take away some of the audiences from the demagogue and the destructionist, and diminish their power to make mischief. We may not, and probably will not, abolish all industrial wars, for human weaknesses and follies cannot be eradicated in a year or a century by any sort of agencies which can be devised; but we have faith that we can and will make the industrial wars fewer and far less destructive than they are now.

GAS AND ELECTRIC POWER IN CONTINENTAL IRON AND STEEL WORKS.

By J. B. van Brussel.

The huge order for the installation of gas engines which, it is announced, has been issued by the United States Steel Corporation, suggests that American steel making is at last to be characterized by some of the economy of resources and operation which has so long been sought on the Continent. The principal features of modern European practice were summarized in our March number as furnace-gas utilization, by-product coking, and electric driving. Mr. Cuntz's article at that time considered chiefly the former two, while Mr. van Brussel takes up more in detail the last-named of these movements.—THE EDITORS.

PRESSURE of competition, and modest endowment in natural resources, early forced the iron masters of Europe to a study of economy unnecessary in the richer Western World. Now that even the lavish American steel industry is showing a disposition to turn from extensive to intensive cultivation, it is of interest to review some of the most important economies which have been applied in Europe in the manufacture of iron and steel, beginning with the ore and following the various processes through to the finished product.

As a general rule, every important works using electricity has its own electric-power generating station. This is usually equipped with either reciprocating-engine generating sets, steam-turbine sets, or gas-engine sets. Steam-driven plants until within the last four or five years were almost exclusively of the type first-named. The recent development in steam turbines and turbo-generators has, however, brought forward this method of generating as a competitor to the steam engine, more particularly in the case of large units. Where blast-furnace gas is available, the argument for the use of gas engines is strong, since power can be generated by this means at considerably less cost than by burning the blast-furnace gas under boilers.

The illustration, Figure 1, gives a view of the central station of Ilseder Steel Works, at Peine, near Hannover (Germany). This station now comprises two Ochelhäuser-Siemens-Schückert gas-engine generating sets, having each a capacity of 1,000 horse power, three-phase, 10,000 volts, 50 periods, 125 revolutions per minute. The engines are driven by blast-furnace gas; the station is to be extended by the installation of two more sets, each of 1,600 horse-power

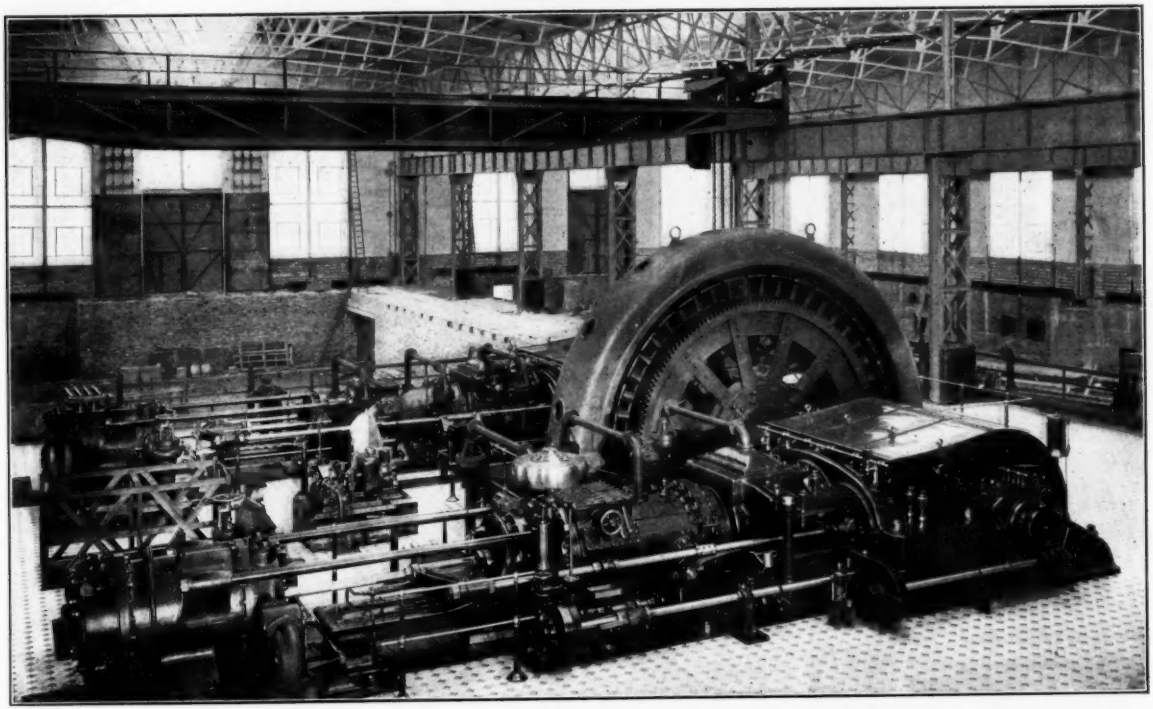

FIG. I. ONE OF THE OCHELHÄUSER-SIEMENS-SCHÜCKERT GAS-ENGINE GENERATING SETS, CENTRAL STATION OF THE ILSEDER HÜTTE, AT PEINE.

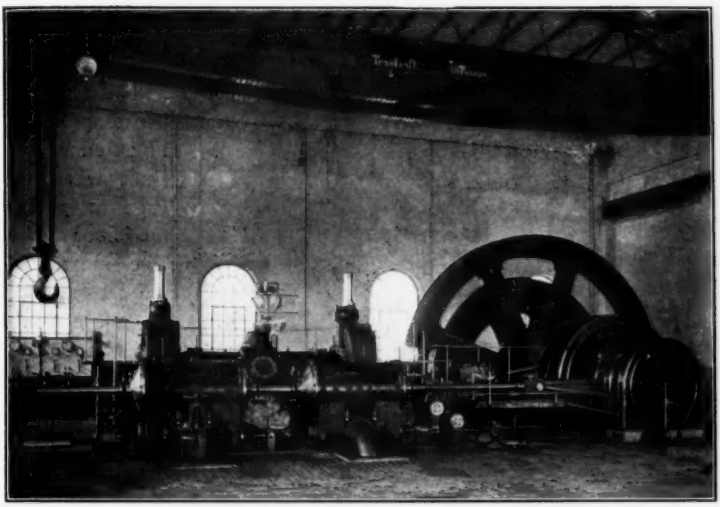

FIG. 2. A KÖRTING-SIEMENS-SCHÜCKERT GAS-ENGINE SET, CENTRAL STATION OF THE GUTEHOFFNUNGSHÜTTE, OBERHAUSEN.

capacity. Figure 2 shows one of the three Körting-Siemens-Schückert gas-engine sets in the power station of the Gutehoffnung Works, Oberhausen (Germany). Each set has a capacity of 1,000 horse power, three-phase, 3,000 volts, 71 revolutions per minute. There are also several other gas engines in the station, all of which are driven by blast-furnace gas. The station supplies power for an 1,800 horse-power motor driving a plate mill, a 1,500 horse-power motor driving a bar mill, an 1,800 horse-power motor driving a rail mill, and about 1,500 horse power distributed among various motors for driving live-rolls, pumps, and auxiliary machinery about the steel mill.

Electric motors are now extensively employed for driving blast-furnace hoists. For this purpose it is necessary that the motors should start frequently and that some form of starting gear be provided which can be readily controlled from a distance. Starters driven by pilot motors or with solenoids for actuating the different contact steps have been used, but they have the disadvantage that considerable power is lost in resistance at each start. There is also some difficulty with this method in arranging for the cage to stop exactly at the right level so that the trucks may be conveniently wheeled off. To accomplish this result a method of control must be adopted which permits of gradually retarding the hoist until a very low speed is

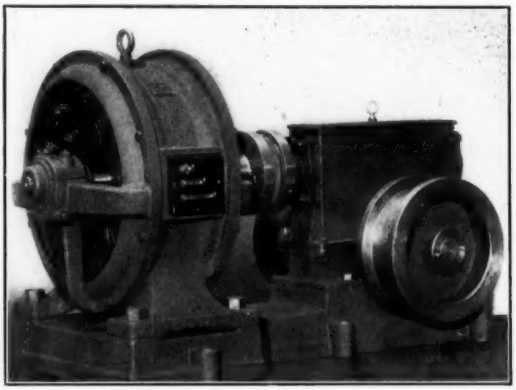

FIG. 3. STANDARD WINCH FOR HANDLING BLAST-FURNACE BELLS.

reached, the current being finally broken and a holding brake applied at the exact instant when the cage arrives at the floor level. The most perfect method of accomplishing the above result, and also of saving practically all rheostatic loss at the beginning of each hoist, is to use a motor-generator running constantly, the armature of the generator being connected in series with the armature of the hoist motor. The field of the generator is controlled by a small rheostat placed conveniently for the operator, by means of which a varying voltage is applied to the armature of the hoist motor. In this way the speed of the hoist motor is controlled by moving the rheostat handle, the speed being dependent upon the position of the handle. The rheostat is best placed on the hoist guides in a position convenient for operating, and to the cage are fixed cams, which automatically shut off the rheostat and gradually reduce the speed of the cage as it approaches the floor level. At the exact instant that the cage reaches the floor level, a raised portion of the cam forces the rheostat handle to the "off" position, thus entirely breaking the circuit and at the same instant applying a holding brake. The cams also prevent the cage being accelerated too rapidly when starting. This method is very simple and reliable, and requires no skill whatever on the part of the operator. The first cost of the installation is somewhat increased but its advantages amply justify the slight extra investment.

No method of absorbing the energy of the moving masses in mechanical brakes will be found satisfactory for stopping a cage at a fixed point, as even small changes in temperature of the brake will vary the distance run by the cage. An amplification of the voltage-control method described above is to provide a small flywheel direct coupled to the motor-generator. The method of control remains the same, but the introduction of the flywheel serves to equalise the

load and reduce the demand upon the generating station at the beginning of each hoist. Figure 3 shows a simple form of motor-driven winch for operating blast-furnace bells. The winch consists of two drums, which are driven through worm-gearing by a motor of either the three-phase or continuous-current type. The wire rope which actuates the mechanism for moving the bell is divided where it passes over the drums into two ropes, each of which makes one turn about one of the drums. By thus dividing the rope, a smaller diameter of drum is permissible. The rope after leaving the drum is connected to a counterweight. By starting the motor in one direction, the bell is lowered until its further motion is limited by a stop. The motor may then continue to revolve, but as the rope on leaving the drum becomes slack through the weight of the bell being taken by the stop, slipping between the rope and drum occurs and the counterweight is lifted no higher. Upon reversing the motor the bell is closed, and at this instant the counterweight is also brought against a stop. The rope is thus slackened where it leaves the drum and the motor is again free to continue running, the rope slipping on the drum. By this simple means, overloading of the motor and complicated gear for stopping it at exactly the right instant are avoided. In the case of three-phase motors, a simple reversing switch, as shown in Figure 4, is used, and a small resistance is connected permanently in the circuit of the rotor. For continuous-current motors a small reversing controller is employed. Motors for driving the blowers for blast furnaces have also been used in some cases, though their application is as yet limited. Electric motors have further been used to a considerable extent for tipping Bessemer converters. The problem presents no special constructional difficulties, and standard motors and controlling apparatus are adapted for this purpose. For driving

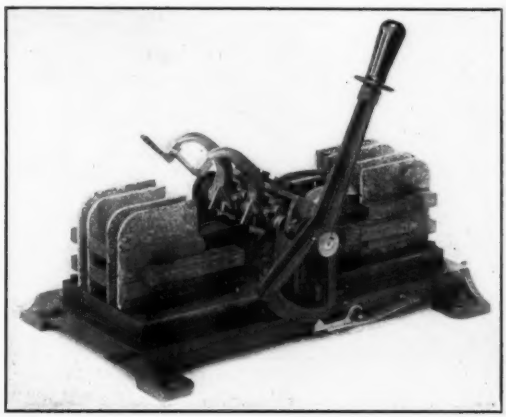

FIG. 4. STARTING SWITCH FOR INDUCTION MOTOR DRIVING WINCH FOR BLAST-FURNACE BELLS.

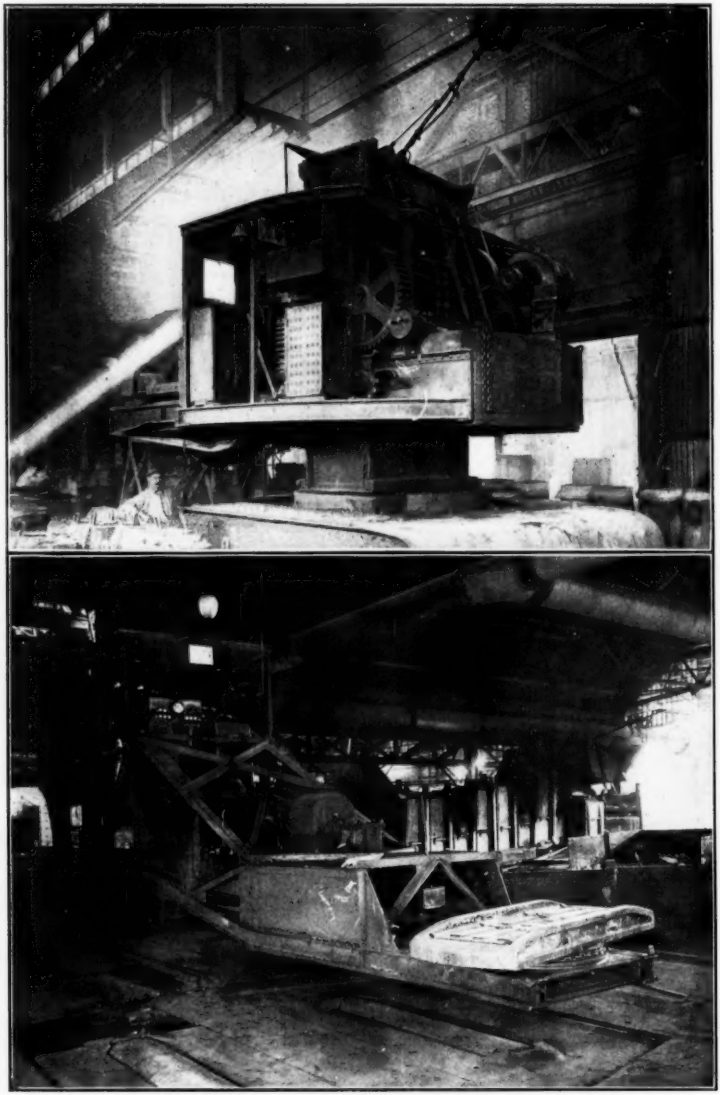

FIG. 7. HEAVY LADLE CRANE, EQUIPPED WITH INDIVIDUAL LIFTING, SLEWING, TIPPING, AND TRAVELING MOTORS.
FIG. 6. AN ELECTRIC-MOTOR DRIVEN CHARGING MACHINE.

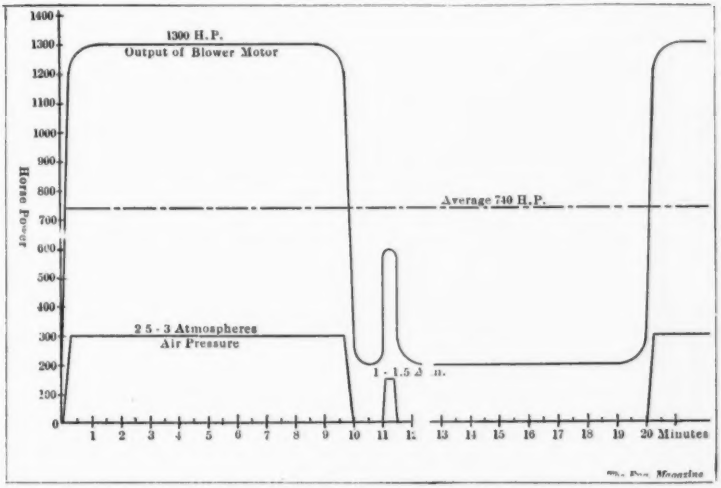

FIG. 5. LOAD DIAGRAM OF A BESSEMER CONVERTER.

blowers for Bessemer converters, the conditions under which an electric motor works are much more interesting, and are shown by the diagram, Figure 5. During the main blow, it will be noticed that the motor has to deliver about 1,300 horse power, this power falling off prior to the afterblow, and a long period then succeeding during which the converter is being recharged and the motor runs at light load. The average power required throughout the entire cycle is about 70 horse power. Various methods are used to regulate the pressure of the blast, some involving variable-speed motors.

Figures 6, 7, and 8 show application of motors to charging machines, ladle cranes, and ingot cranes. In most cases standard crane-type motors and controlling gear may be adapted for this purpose. Precaution must be taken, however, that the motors are of ample dimensions, and are protected against excessive heating such as would be caused by direct radiation from molten metal.

There is probably no class of service in which electric motors are subject to more severe strains than in driving of live rolls. For reducing the severity of such shocks upon the motors, tight and loose belts have sometimes been employed. Another method is to use a set of reversing gears and friction clutches which allow the motor to run continuously in one direction. With both of these plans, however, the parts are liable to rapid wear and the cost of upkeep is high. By far the most usual practice at present is to gear the motors direct to

the rolls, making the motor so substantial in construction, and designing it with such high overload capacities from the commutation standpoint, that it will withstand successfully a reversal of current at full speed, the torque exerted by the reverse current being used for bringing the rolls to rest. This method is much the simplest and most convenient mechanically, as it affords a means of starting and reversing the rolls in a minimum of time, and with a properly designed motor and controller the results obtained by it are excellent. For meeting such heavy duties, special motors (of which Figure 9 shows

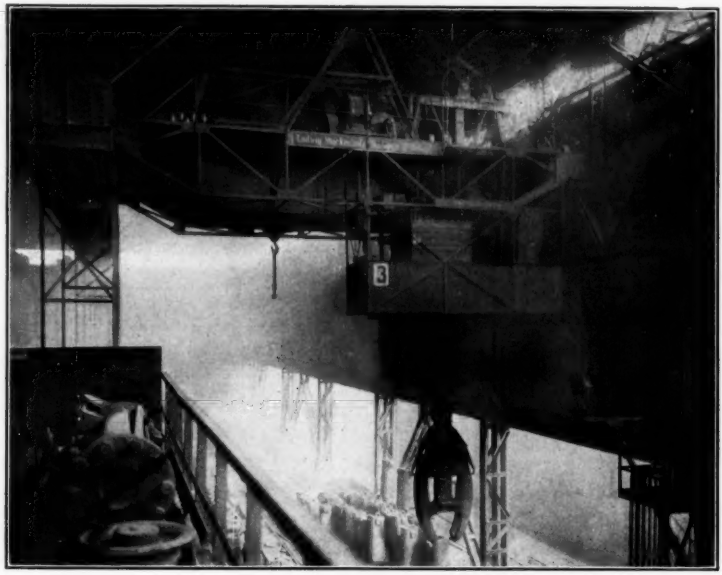

FIG. 8. AN ELECTRIC INGOT CRANE.

an example) have been designed. It will be noticed that the shaft at the bearing end of these motors is supported in the most rigid manner; the metal forming the bearing casing is carried as directly as possible to the supporting feet, thus avoiding overhand and the possibility of chattering due to the heavy intermittent strains which come upon the motor pinion. The electrical characteristics of the motors are also such as to enable them to withstand successfully the heavy rush of current which occurs both in starting and at the moment of reversal. Scarcely less arduous is the service which falls upon the controllers, and for such work standard or tram type controllers are

entirely unsuitable. In Figure 10 is shown a type of controller which has given excellent results in practice. It is built for either three-phase or continuous-current motors, and consists essentially of a marble panel upon which are mounted heavy contact blocks. The current is controlled by contact fingers with massive carbon tips, the motion of the fingers being obtained by means

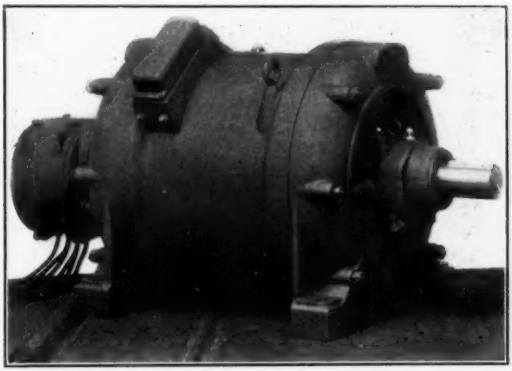

FIG. 9. THREE-PHASE MOTOR FOR DRIVING LIVE ROLLS. NOTE HEAVY END SHIELD SUPPORTING BEARINGS.

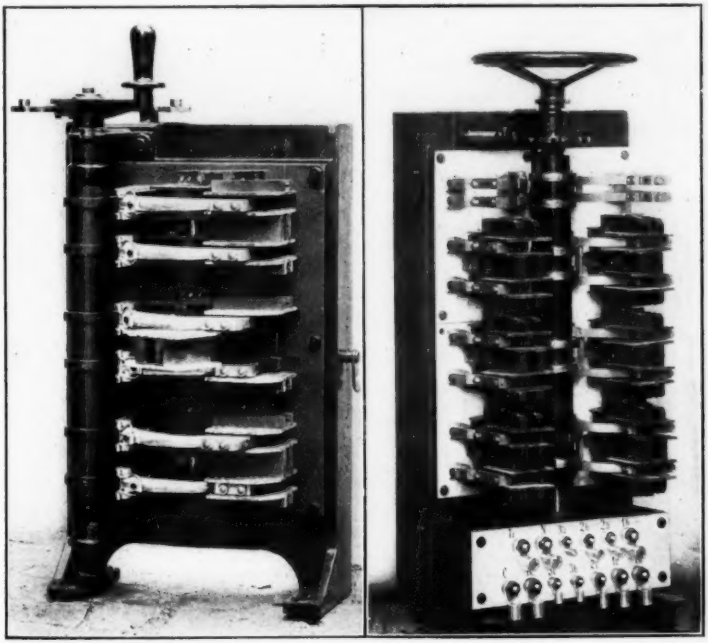

FIG. 10. CONTROLLERS.

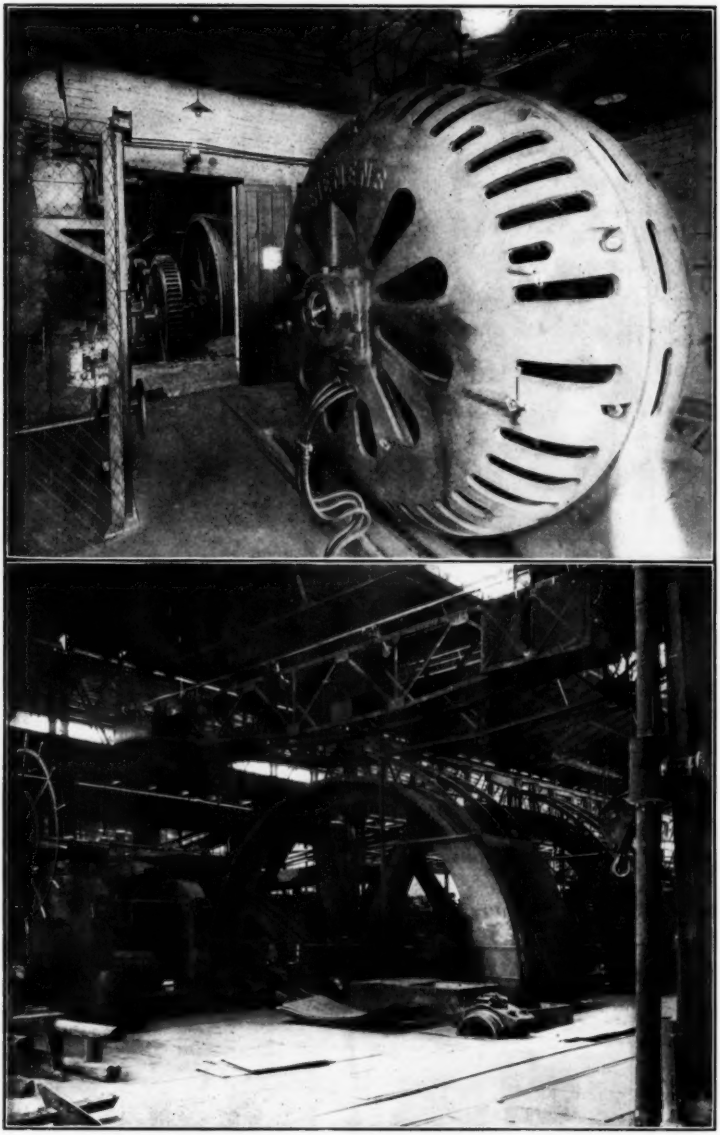

FIG. 12. INDUCTION MOTOR, DRIVING PLATE MILL BY ROPE TRANSMISSION.
FIG. 11. PLATE ROLLS, ROPE-DRIVEN BY ELECTRIC MOTOR.

of a cam shaft with handle or hand wheel. Figures 11 and 12 show typical motors arranged for driving main non-reversing rolls. The massive construction of these motors will be noted, especially the arrangement of the bearings and base-plates, which are designed especially for withstanding the heavy strains that are met with in such drives. Figure 13 shows a motor-driven starter for one of these motors. The contact blocks are mounted upon a marble panel. The sliding contact shoe is operated by a traversing screw worked by a pilot motor, which may be controlled from a distant point. The resistances consist of a cast-iron grids, mounted behind the panel. For large motors of the three-phase type special starters have been designed, of which one of the most interesting is the hot-water type, consisting of a series of contact plates suspended in a tank. By means of a small motor-driven circulating pump, water is made to rise or fall in the tank and submerge the contact plates to any required depth. The water when it comes into contact with the plates boils at the surface and gives off a small quantity of steam which escapes through an outlet pipe. By thus taking advantage of the great latent heat of steam a starter of moderate size and cost can be produced capable of carrying very heavy currents. These starters have been used with great success for main roll motors of large size. An illustration of such a starter is shown in Figure 14. As auxiliary motor-driven machinery, Figure 15 shows an electrically-driven transfer table, with

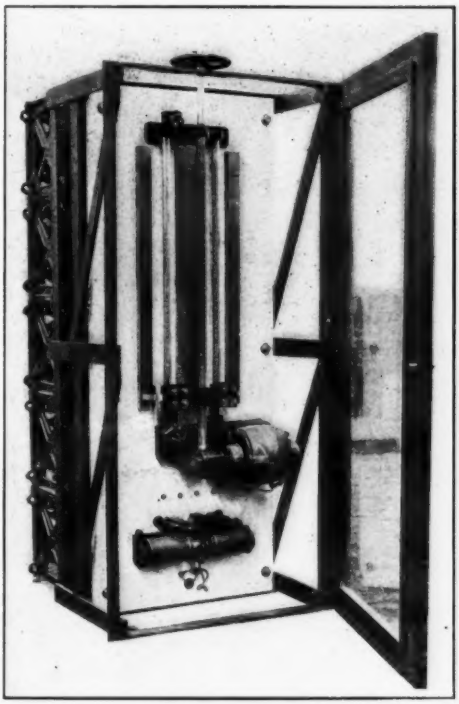

FIG. 13. MOTOR-DRIVEN STARTER.

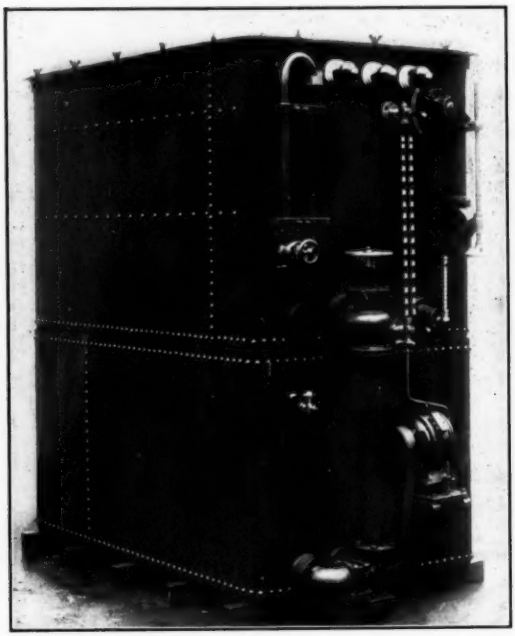

FIG. 14. HOT-WATER STARTER FOR AN 1,800 HORSE-POWER MOTOR.

controller in the background and Figure 16 depicts a rail-bending machine. Figure 17 shows the arrangement of driver's platform in an electrically-driven rolling mill.

The motors used for most purposes about steel works have a very intermittent load, with periods in which the motor is either standing or running light and drawing only a small amount of current. For the smaller motors about the works this variation in power required does not react unfavorably upon the generating station, since there are usually a large number of motors, and their variations tend to neutralise each other and produce an aggregate demand of fairly uniform character. In the case of large motors such as those for driving main rolls, however, the load variation assumes more serious proportions, and it is sometimes desirable to screen the power station from the excessive peak load of these large motors. The most obvious method of doing this is to provide a flywheel on the rolls or motor shaft of sufficient weight for providing, without an excessive reduction in speed, the excess power required at each pass, the flywheel being restored to full speed between the passes. In adopting this plan, care must be taken to design the motor and its control gear so as to permit a drop in speed without a corresponding rise in current demand, and thus to enable the stored energy of the flywheel to be utilised. The practical means of accomplishing this in the case of continuous-current motors is to provide a compound field winding,

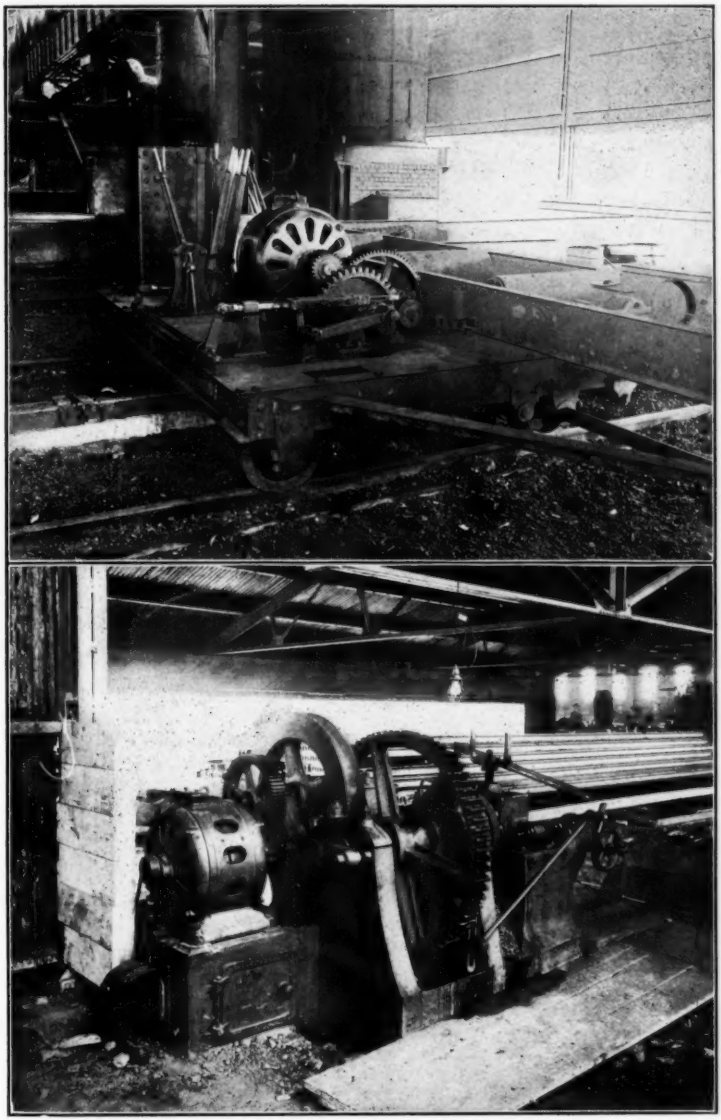

FIG. 15. AN ELECTRICALLY DRIVEN TRANSFER TABLE.
FIG. 16. ELECTRICALLY DRIVEN RAIL-BENDING MACHINE.

FIG. 17. ARRANGEMENT OF DRIVERS' PLATFORM IN AN ELECTRICALLY DRIVEN ROLLING MILL.

and with induction motors to insert a fixed or a varying resistance in the rotor circuit so as to increase the slip of the motor during the period of heavy load. When it is applicable, this plan is the simplest which can be adopted. There are cases, however, in which the peak loads are either so high or of such long duration that, in order to neutralise them completely by means of a flywheel direct-coupled to the motors or rolls, the weight of the flywheel required would be impracticable. In such cases the excess demand on the generating station may be supplied by a storage battery; but the first cost of a storage battery is high, and also its cost of upkeep; a simpler means of accomplishing the same purpose is attained by coupling the flywheel to the motor-generator; this arrangement enables the flywheel to run at a much higher speed, and therefore, with the same weight of wheel, to store a greater amount of energy. A still better but slightly more costly arrangement is to have a separate generator on the motor-generator set for each main-roll motor. When this is done, a simple means is also afforded for varying the speed of either main-roll motor by changing the field strength of its corresponding generator.

In main reversing rolls, the absolute powers required at the different stages of elongation vary greatly with the temperature of the billets. During the initial stages, when the billet is short, the loads are heavier and their duration shorter. The powers then gradually decrease, and the length of time during which the power is applied increases as the billet elongates, until finally we have the long, low powers of the last passes. In considering the design of the electric drive for such a mill very heavy powers are involved. To be successful, a method must be found which will obviate the necessity of handling directly the enormous currents corresponding to such powers, and the method must also be one which will screen the generating station from the enormous fluctuations in the load demand throughout the process of rolling. A method which accomplishes both of these results is the Ilgner system, and Figure 18 illustrates a type of flywheel converter used with this system for driving main reversing rolls. The mains from the generating station are led to the motor of the flywheel motor-generating set. The generator of this set delivers continuous current to the motor driving the mill, the armatures of the generator and mill motor being connected in series. The field of the mill motor is separately excited, the exciting current for this purpose being obtained from a small auxiliary generator direct-coupled to the motor-generating set, but where the main supply is continuous current, this auxiliary machine can be dispensed with. The field

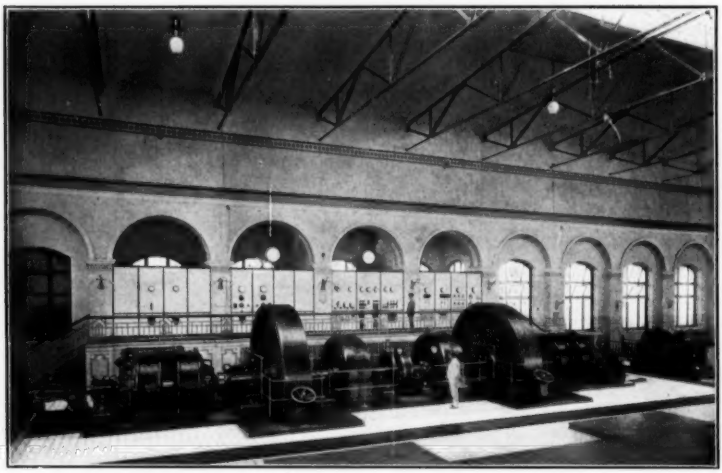

FIG. 18 TYPE OF FLYWHEEL CONVERTER USED WITH ILGNER SYSTEM FOR DRIVING REVERSING ROLLS.

of the generator on the motor-generator set is controlled from 0 to a maximum positive or negative by means of a rheostat placed on the operator's bridge. By moving the rheostat level the field of the generator is thus varied, and the speed and direction of rotation of the mill motor are controlled. The system involves the handling only of a small exciting current required for the generator field. The flywheel is proportioned so that by a reduction of about 15 per cent in speed, it is capable of supplying energy equivalent to the load peaks above the average power line. The speed of the mill motor corresponds to the position of the control lever, and its direction of motion also follows the position of this lever. The system has the advantage that its efficiency remains practically constant at all speeds, and that the power required for accelerating the masses at the beginning of each pass is regained and stored in the flywheel when the masses are brought to rest for the reverse pass. The generating station therefore generates an amount of power corresponding to the average required at a uniform rate, and thus works under very efficient conditions.

GENERAL PRINCIPLES IN THE CONSTRUCTION OF MODERN GAS PRODUCERS.

By R. E. Mathot.

The use of fuel in internal-combustion engines has not only the interest of its vast commercial and technical importance, but in addition that always attaching to a new development which has grown vigorously along many branches and is but now arriving at maturity and fixity of form. Standard principles, here as elsewhere, are the fruit of the collated experience of many experimenters in different parts of the subject. Mr. Mathot's work, as specialist in this field of mechanical engineering and industrial application, has been to gather these standards from all sources, on both sides of the Atlantic. In a preceding paper he laid down the leading principles controlling the design and construction of the gas engine, as he accepts and adopts them in his practice. He completes the review in the following pages by treating in the same way the settled elements of producer design and installation.—THE EDITORS.

ANY perfection attained in the construction of gas engines, and even the utmost ingenuity applied to methods for assuring their regular operation, would have no practical interest if it were not possible to supply them cheaply with power gas. This consideration eliminates at the outset city gas and petrol spirit for any industrial installations exceeding 15 to 20 horse power and operating continuously.

The solution of the problem has been found for the metallurgical industry by the utilization of blast-furnace gas, and elsewhere by the introduction of gas producers. These are divided into two general categories—pressure, (Figure 1), and suction, (Figure 2). Of these the former are the more complicated. They require the installation of a holder to contain a reserve supply of gas and of a steam boiler or a fan. They involve a certain measure of danger through the possible escape of carbonic oxide and the explosions which may occur. On the other hand, they are particularly well adapted for the supply of a number of separate motor units installed at a greater or less distance from one another and from the generating apparatus.

Producers, of whatever system, include three principal groups of apparatus: the generator, the vaporizer, and the purifier. We shall consider, particularly, producers operating with anthracite, semi-anthracite, or coke, setting aside for the present bituminous-coal producers, which necessitate special appliances and which, further, have

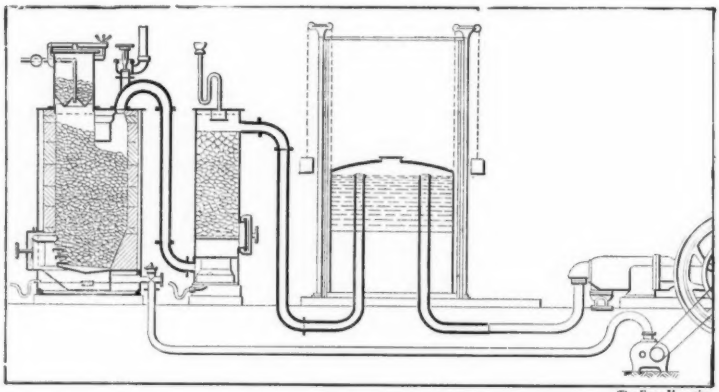

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FIG. 1. DIAGRAM OF ARRANGEMENT OF PRESSURE PRODUCER.

not in general up to the present time given substantial practical results.

THE GENERATOR.

The generator consists of a vertical shell, cast or built of steel or iron plates, in which is placed a lining of refractory brick generally separated from the shell by a bed of sand, asbestos or other non-conductor of heat. The fuel is charged into the top of the retort which is closed by a double valve to prevent the entrance of air into the apparatus during charging. This double seal is indispensable and the outer cap should be attached to the apparatus by a hinged joint. The arrangement with the outer cover entirely removable is not to be recommended. Figure 3.

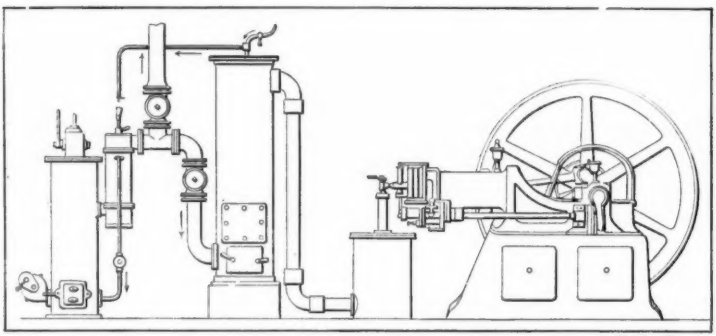

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FIG. 2. DIAGRAM OF ARRANGEMENT OF SUCTION PRODUCER.

At the base of the internal brick lining is installed a grate through which the ashes fall. In most producers this grate is horizontal and substantially of the same diameter as the producer lining. The result with fuel containing a large proportion of cinders (10 to 15 per cent) is that the grate is very soon choked, unless the ash-pit doors are frequently opened for the purpose of cleaning. This operation, by frequent admissions of air, necessarily disturbs the production of the gas. This disadvantage may be avoided by using a grate in the form of a basket, which affords a large area for air passages. Figure 4. Into the ash pit is admitted the air mixed with steam, which is to produce with the incandescent coal the reactions yielding fuel gas. The weight of steam introduced varies with varying types of apparatus. In general, it is close to the weight of the combustible consumed. Further, it may be the greater, the hotter the working of the furnace. The higher the temperature above the grate, the richer is the gas produced. The most rational and most efficient means of securing this high temperature is to superheat the mixture of air and steam before their introduction into the ash pit, but certain precautions are necessary in securing this result. The grate should be so set and constructed as not to be subject to rapid deterioration. The heat employed for the superheating should be obtained exclusively from gas which has passed out of the producers. Taking it from the incandescent zone or even from the ashes must be carefully avoided, under penalty of receiving no benefit whatever from the superheat so far as concerns the combustion of the fuel.

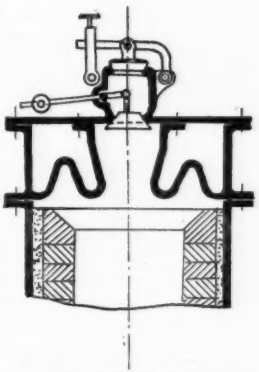

FIG. 3. DOUBLE SEAL FOR GENERATOR TOP.

The use of superheat necessarily excludes any arrangement which involves the maintenance of a reserve of water in

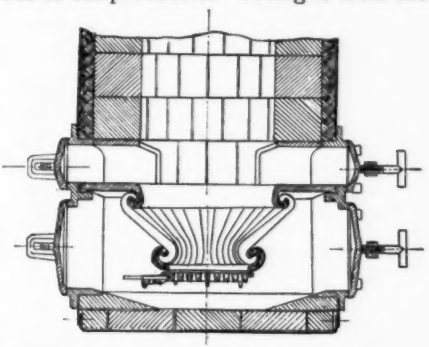

FIG. 4. BASKET GRATE FOR PRODUCER.

the ash pit, whether this be done with a view of protecting the grate from over heating or whether for cooling the ashes to prevent the formation of clinkers, which happens particularly with coal containing considerable iron.

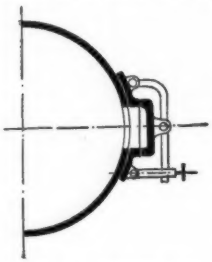

FIG. 5. METHOD OF CLOSING FIRE DOORS.

The doors of the fire-pot and of the ash pit should be hermetically closed, metal to metal. They are commonly fastened by hinged bolts furnished with wing nuts (Figure 5). Some generators have been constructed with open ash pits (Figure 6). This arrangement presents some advantages in so far as it permits the stirring of the fire or the removal of ashes at any time without disturbing the operation of the apparatus, but at the same time it prevents the preheating of the air.

The gas is usually drawn off from the periphery of the apparatus in the annular part surrounding the charging hopper. This design possesses the advantage of favoring the discharge of the gas from the whole mass of the fuel over a large surface, thus reducing the speed of the circulation and preventing the entrainment of too much dust. On the other hand, it has the disadvantage of creating a flow of air along the walls of the generator, because that is the passage of least resistance, so that a certain quantity of air may pass out with the gas without sufficient contact with the incandescent fuel to complete the proper reaction. I therefore recommend the use of apparatus with a central gas discharge, giving this exit pipe dimensions great enough to prevent any abnormal entrainment of dust. In connection with this, it is desirable to furnish the gas exit pipe with a dust chamber which can be easily cleaned (Figure 8). It is well to provide, at several points on the height of the producer shaft, peep holes through which the position of the incandescent zone may be observed. Around the charging hopper, also, openings should be

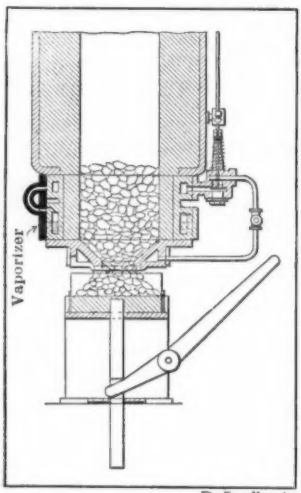

FIG. 6. GENERATOR WITH OPEN ASH PIT.

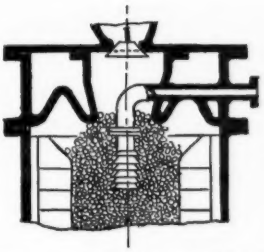

FIG. 7. CENTRAL GAS DISCHARGE.

FIG. 8. DUST CHAMBER.

provided through which, if necessary, a poker may be introduced to quicken the descent of the fuel. Figure 9.

To summarize, the following are the principal conditions which should be secured in the design and construction of the producer generator. That is to say:

A double-doored charging hopper designed to give good distribution of the fuel.

Internal lines assuring easy descent of the fuel.

Heating of the mixture of steam and air by which combustion is maintained.

The use of grates of large area, cleaned so far as possible from the outside without the need of opening the ash pit.

Absolute tightness of all the joints of the apparatus, especially of those which are in contact with the fuel gas after its formation.

On the pipe through which the gas passes from the producer is placed a connection communicating with a chimney open to the air. This must be closed by a valve which is absolutely tight. It serves for blowing off the gas and smoke during the firing up of the generator, and it is used also to maintain a natural draft sufficient to support a slow rate of combustion during periods of stoppage. (Figures 10 and 11).

The generator should be so made that it can operate continuously for six or seven days without being extinguished, and it should be capable of maintaining a banked fire for ten or

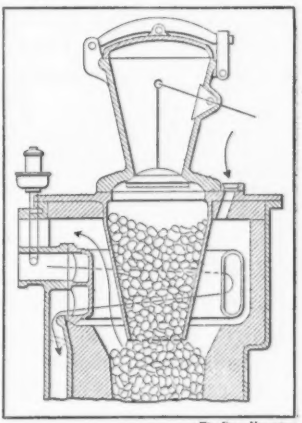

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FIG. 9. POKER OPENING NEAR CHARGING HOPPER.

twelve consecutive hours of stoppage, so that for putting it into service again the only necessity is the reviving of the fire. The necessary time for reviving the fire under these conditions with a suction producer should not exceed ten or fifteen minutes, and the time requisite for obtaining a gas suitable for use, starting with the generator cold and firing it anew, should be about one-half hour.

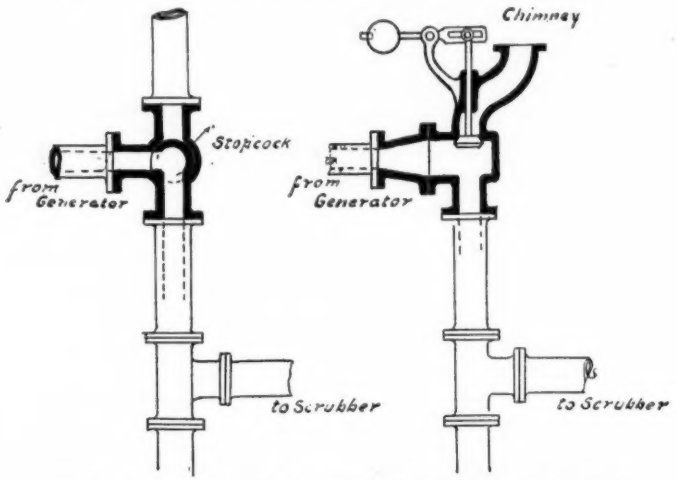


FIG. 10, 11. CONNECTIONS OF GAS DISCHARGE PIPE WITH CHIMNEY.

For reasons of economy the refractory lining should be made of such form that it can be built and thereafter maintained with fire-brick of a single standard shape.

THE VAPORIZER.

A large numer of types of vaporizer have been brought out. We may divide them into two categories—those which are placed outside the generator and those which form a part of it.

Independent Vaporizers.—These consist of a sort of boiler at atmospheric pressure heated by means of the gas passing from the generator. They are made in various forms. Many of them are characterized by a general defect of installation in that their cleaning and the removal of scale is very difficult. From this point of view, especially, those fitted with tubes of the Field type should be absolutely proscribed if the water with which they are to be supplied contains any notable proportion of calcareous sediment. (Figures 12, 13).

Internal Vaporizers.—All generators with interior vaporizers are

based upon the Otto-Deutz, Wiedenfeld and similar types. They are composed of an annular vaporizing chamber disposed about the upper part of the generator, under which the hot gas circulates (Figure 3). This vaporizer is generally cast. It should be so designed as to support without rupture the effects of expansion and should be provided with a removable cover or with cleaning doors to permit the removal of incrustations. These latter, especially in large apparatus, might cause rupture.

Although they do not constitute a boiler, properly speaking, the elements of superheater apparatus may be included among the classes of available vaporizers. These are, in effect, flash boilers, so arranged that the feed water falls drop by drop upon a surface superheated by the passage of the gas. The evaporation of the water proceeds simultaneously with its inflow.

Some vaporizers are placed in the ashpit of the generator (Figure 6). I am of the opinion that this position is inadvisable, because the evaporation is produced by means of the heat of the ashes, which are thus rapidly cooled and in consequence cannot by radiation contribute effectively to the maintenance of a high temperature in the zone of incandescence.

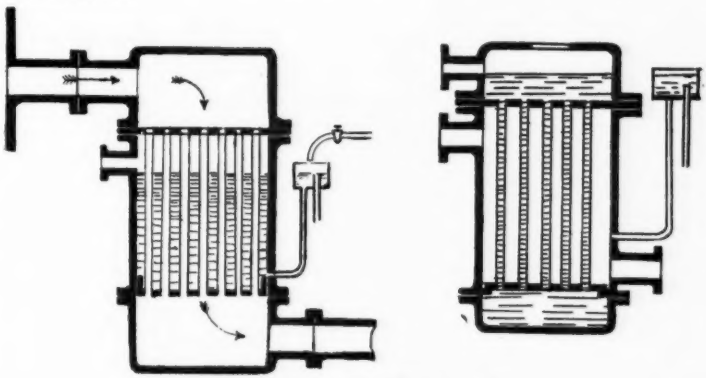


FIG. 12, 13. TUBULAR VAPORIZERS.

PURIFICATION.

In pressure generators effort is generally made to purify the gas as completely as possible. This, moreover, is relatively easy to do, because the gas is delivered under pressure sufficient to force it through several pieces of purifying apparatus containing chemicals or absorptive substances designed to remove the impurities from the gas. So far as suction producers are concerned, purification, prop-

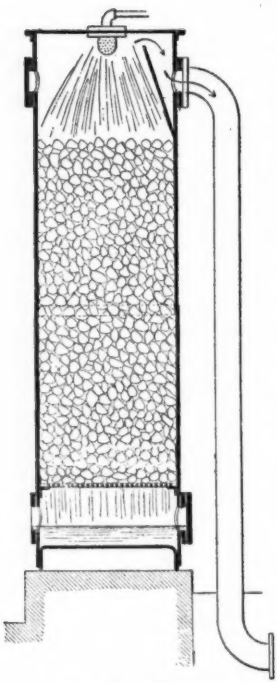


FIG. 16. SCRUBBER.

erly speaking, is usually discarded, and we are content to employ scrubbers (Figure 16) in which a simple washing of the gas is accomplished by means of jets of water falling through a mass of coke conveniently arranged in a closed cylinder. Occasionally, in large installations, two scrubbers are placed in series, or a single scrubber is followed by a purifier containing wood fibre or some other material serving to effect a physical purification (Figure 17). The discharge of the washing water from the scrubber is effected by means of an overflow siphon, or in other cases by a simple vertical tube dipping into the tank which serves to form an hydraulic seal (Figure 18).

In filling the scrubber the largest pieces of coke should be placed at the bottom and the finer fragments toward the upper part. Whatever may be the form of the scrubbers and the purifiers, they should be provided with doors permitting the cleaning of the apparatus and the easy removal and replacement of the materials with which they are filled. Many scrubbers are equipped with a single opening only at the base to allow the removal of the coke. This is a very bad arrangement, because the filling of the apparatus requires the unbolting and removal of the whole upper cover to which piping is usually attached. This annoyance can be entirely avoided by furnishing the apparatus with a charging door which can be quickly and easily opened (Figure 19).

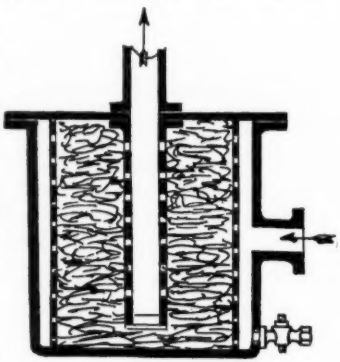


FIG. 17. PURIFIER.

PIPING.

Suction producers for power gas should be provided with a gas

reservoir placed in the piping system between the scrubber and the motor, and of dimensions sufficient to minimize the effects of variation in the suction caused by the motor. This gas pot should be provided with a hand-hole for cleaning and with a discharge cock for emptying out the water which may accumulate in it.

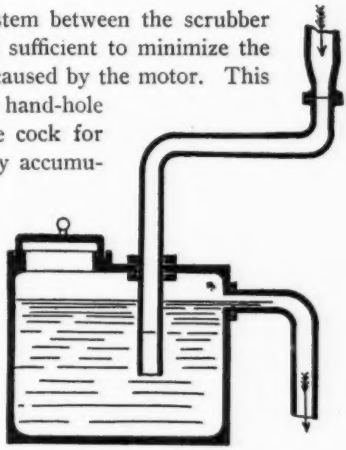


FIG. 18. HYDRAULIC SEAL.

Generally speaking, all the piping connecting the various parts of a producer system should be connected at the joints by tees or crosses, or preferably, by capped elbows, the object being to make the examination and cleaning of the pipes easy and convenient (Figures 20 and 21). All joints must be perfectly tight.

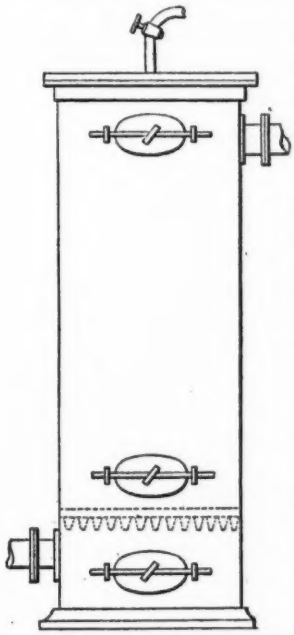


FIG. 19. SCRUBBER WITH CHARGING DOORS.

It will prove useful to place cocks at several points on the piping system with a view of installing manometers or pipes for drawing off the gas in order to make check observations on the working of the apparatus.

The washing water from the scrubbers carries sulphurous acid, ammonia, and sulphuretted hydrogen. It therefore gives off a disagreeable odor which necessitates precautions for its removal, especially in case of installations in settled localities.

The purification of the gas, whether obtained by scrubbers or by purifiers of whatever system, should be so complete that the admission valves of the motor to which the gas is supplied should not need cleaning oftener than twice a week. This result is very easily attained when the fuel employed is anthracite or lean coal (semi-anthracite) containing 6½ per cent of volatile combustible and 8 per cent of

ash. It is, however, necessary that the scrubber shall be made large enough, that the coke shall be properly placed in it, and that the quantity of water employed for washing shall be ample to cool the gas completely.

Accessories.

The installation of pressure generators involves a number of accessories.

Blowers.—The blast may be secured by means of the steam jet, in which case it is necessary to provide a boiler. Steam should be furnished to the blower at a pressure of at least five atmospheres and the duty should be regulated by automatic control in accordance with the height of the gasometer. The draft for the producer may also be obtained by means of a fan driven either by the motor itself or by independent power.

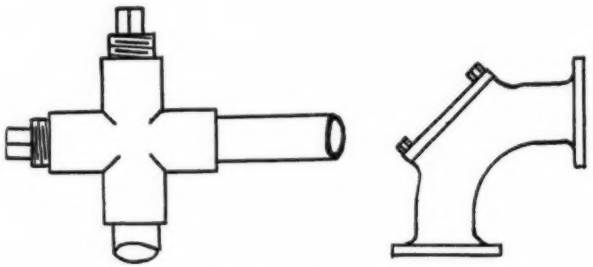


FIG. 20, 21. FORMS OF CONNECTIONS FOR GAS PIPING.

Gasometer.—This is constructed in the usual form adopted by gas works. The tank should be of sufficient dimensions to hold about 100 litres (say 4 cubic feet) of gas per effective horse power per hour of the gas engine supplied. A special device should be placed in the interior of the tank to prevent water from entering the suction pipe of the motor through any stoppage in the production of gas.

Most of the accidents which have happened in pressure-generator installations have been caused by the gasometer, and have arisen from the fact that either by wrong manipulation or by an unforeseen admission of air, the gas holder has been filled with an explosive mixture of air and gas. It is consequently indispensable to equip every stop cock about the gas holder with a wire-gauze diaphragm designed to prevent any possible back draft of flame.

THE INSTALLATION OF PRODUCER-GAS ENGINES.

In a preceding article (THE ENGINEERING MAGAZINE, June, 1907), we examined from the point of view of construction the most important features which enter into the design of gas engines operating with power gas. It remains now to look at certain problems which arise in their installation properly speaking. These are especially:

The construction of foundations.

Water circulation for the several parts of the apparatus.

Piping for the gas and the exhaust.

Starting appliances.

Foundations.—Motor foundations must be designed according to the character of the soil upon which they rest. They must embody a sufficient mass to resist the violent strains which are put upon the anchorage bolts when the motors are running. They should be constructed of materials of good quality, laid in mortar containing two parts of good sand and one part of cement. In order to avoid the transmission of vibrations, the foundations must be kept entirely distinct from any other masonry in the neighborhood, and if necessary they should be set in an isolated pit.

Engine builders generally content themselves with supplying to their patrons an ordinary foundation plan without troubling themselves to look into the special requirements of each installation. This mode of procedure may result in very serious consequences for the buyer. The latter, therefore, as a measure of prudence, should employ an engineer competent to determine what special conditions, if any, must be recognized and provided for.

Water Circulation.—Here, also, the necessary arrangements must be studied out for each particular case. A gas-engine installation supplied with producer gas normally consumes, per horse-power hour under full load, 25 litres for the cooling of the motor (if the cooling water is wasted) 15 litres for washing the gas in the scrubber, and one-half litre for the vaporizer supplying the generator; this makes a total of, say, 40 litres (about 11 gallons). Instead of wasting the cooling water from the motor, we may use a thermo-siphon or cooling tower. In this case, the consumption of water for the motor becomes, we might say, nil. It is necessary only to make up for losses by evaporation and these would scarcely exceed a half pint per horse-power hour. The washing water from the scrubber must be considered as waste in almost every case. Nevertheless, if it is imperative to economize water to the utmost possible, special devices may

be used to reemploy this wash water almost indefinitely. The water for the vaporizer is necessarily lost, as it is converted into steam, and by its passage through the incandescent fuel is later decomposed and recombined into hydrogen and carbonic oxide.

Waste of the cooling water from the motor is not advisable, except for small motors and in situations where there is an available water supply carrying but a very small percentage of lime salts in solution. These, if present, are deposited rapidly in the motor casing, interfering with the circulation of the water and preventing the normal transmission of heat from the metal walls thus covered with deposits. This may even result in accident and in the breakage of parts. Cooling by means of reservoirs with thermo-siphon is not to be recommended for motors exceeding 50 horse power; and when, on account of local conditions, it is necessary to place the reservoir at a considerable distance from the gas engine, a circulating pump may profitably be introduced into the circuit. In this case a by-pass with stop cock should be provided in the piping system (Figure 26). The capacity of each reservoir is generally from 1,500 to 2,000 litres. Their number should be determined by the total quantity of water to be handled, which should correspond to 200-250 litres per horse-power hour in the case of motors governed by hit or miss, and 250-300 litres for motors governed by variable admission. The most rational solution is, therefore, to use cooling towers.

Two arrangements may be made, depending upon whether it is desired that the circulation shall be by open flow, thus permitting constant control of the water temperature, or whether it is decided to adopt an entirely closed circuit. In the former case, the water flows by pressure due to difference of level from the cooling-tower platform to the motor, circulates in the cylinder jacket, and discharges freely into a funnel from which it passes by a pipe into a cistern to be again withdrawn by a pump forcing it to the top of the

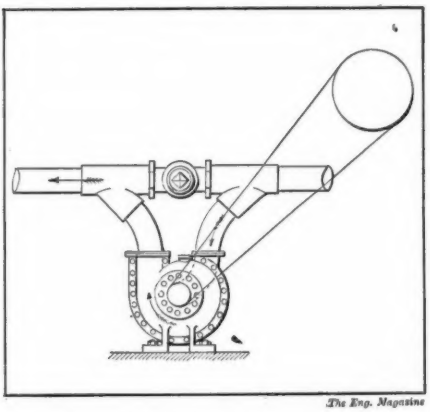


FIG. 26. CIRCULATING PUMP WITH BY-PASS.

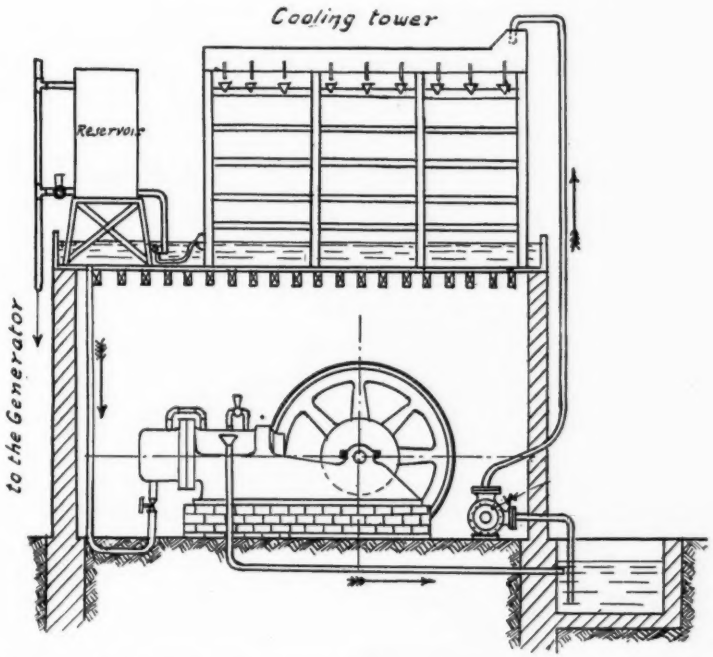


FIG. 27. COOLING-TOWER INSTALLATION WITH OPEN-CIRCUIT CIRCULATING SYSTEM.

cooling tower (Figure 27). It should be noted that this arrangement has the disadvantage of requiring that the pump shall handle hot water (100 to 120 degrees F.) and that this pump must, therefore, be so installed that the temperature of the water does not interfere with the suction. As a precautionary measure, a tank should be provided large enough to contain a reserve water supply sufficient for supplying the motor during one or two hours of operation with the cooling water wasted, in case there should be any interruption to the working of the pump. This end may be secured by having two outlets from the tank to the water-supply pipe, the lower one furnished with a stop cock, which is opened only in case the motor-cooling water is to be wasted.

In a closed-circuit installation the pump receives on the suction side the cold water flowing from the tank on the platform above and forces it back through the motor jackets to the top of the cooling tower (Figure 28). With this arrangement it is not possible to ob-

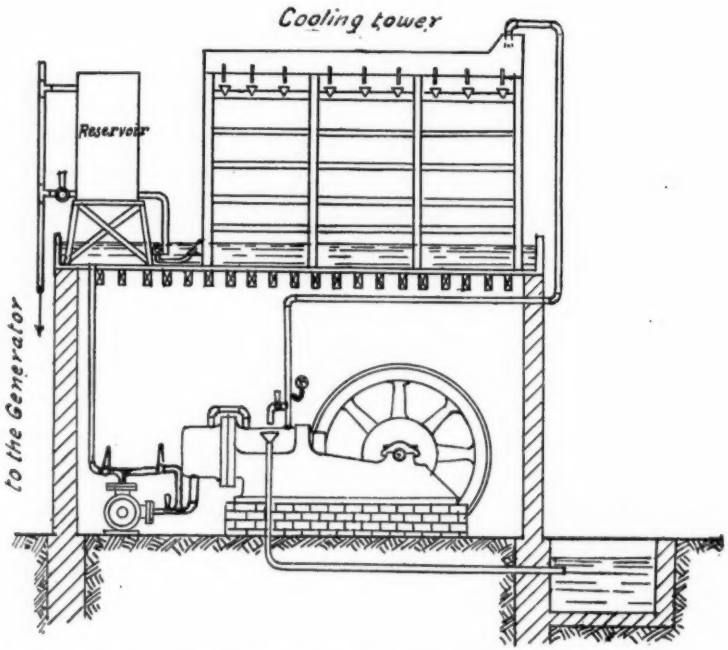


FIG. 28. COOLING-TOWER INSTALLATION WITH CLOSED-CIRCUIT WATER CIRCULATION.

serve whether the circulation is proceeding normally by watching the discharge jet. Nevertheless, a gauge may be installed on the return pipe, just at the exit from the motor, and its oscillations will indicate how the circulation is proceeding. With this form of apparatus, also, provision must be made for a reserve supply of cooling water to be used and run to waste in case of a pump breakdown and consequent repairs. The piping system must, therefore, be provided with three stop cocks to by-pass the circulation and permit cutting out the pump.

As cooling by means of cooling towers has for its purpose on one hand economy of water, and on the other hand the prevention of incrustation or scale in the motor jackets, we must evidently avoid the use of a single reservoir for feeding both the motor and the scrubber. Operation under this plan would manifestly involve a constant admixture of fresh water with that which had been once used for cooling purposes, and in consequence the lime deposits would be

much greater than if the same quantity of water were continuously employed over and over solely for motor cooling.

The scrubber is best supplied by means of a regulating tank of one or two cubic-metres capacity, placed, whenever possible, at a height of five or six metres above the top of the scrubber, the purpose of this being to assure the delivery of the water to the scrubber under sufficient pressure to scatter it in a fine rain from the sprinkler. If the pressure is insufficient it will flow in mass in a single jet or stream from a central point and the washing of the gas in the apparatus will be ill accomplished. This regulating tank should be placed at a higher level than the platform of the cooling tower for the motor, so that by the use of a ball cock the small quantity of water necessary to compensate for evaporation may from time to time be supplied to the cooling tower.

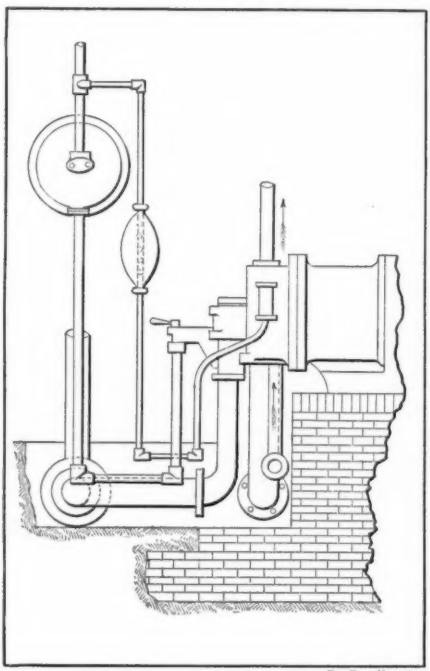
Water which has been used for washing the gas in the scrubber contains in solution ammoniacal salts and sulphuretted hydrogen, giving it a very disagreeable smell. If the coal was highly sulphurous it contains also sulphurous acid in solution, and in the presence of air this may undergo oxidation and give rise to the production of sulphuric acid. This water must, therefore, never be allowed to flow through piping or into receptacles of zinc, for these would be immediately attacked. Even iron will be rapidly affected if the proportion of sulphuric acid contained in the water is at all considerable. In order to avoid the escape of the unpleasant odors it is well to provide the receptacle in which the water from the scrubber is received with a siphon overflow. It is also a good plan to cover this receptacle with a floating layer of oil, which prevents the odors from escaping to the outer air. In the case of installations outside of city limits, where there are no drains, necessity often compels the running away of these waters through open channels. From this may result a disengagement of offensive odors which may give rise to damage suits from the neighbors. The possibility should never be lost sight of when the location for a producer-gas motor plant is under consideration.

Water supply for the vaporizer is usually drawn from the pipe which supplies washing water to the scrubber. Whatever arrangement may be adopted, the whole piping system should be easily accessible, and should be provided with all stop cocks necessary for control of the circulation or for drainage of parts exposed to frost and for enabling emergency supplies of water to be taken off through hose.

Piping for Gas Supply and for Exhaust.

In small gas-engine installations, especially in city neighborhoods, the motor is usually connected with the city gas pipes, thus making it unnecessary to fire the producer when power is required for a few hours only. Consideration must therefore be given to the supply piping to the motor from the city gas mains and to the piping for the exhaust. So far as producer-gas is concerned, the piping has been considered as part of the generating apparatus and has been discussed under that head in preceding sections of this article.

A piping system for illuminating-gas supply to a motor should be most carefully installed to avoid all leakage. Drain cocks must be put in wherever water might accumulate. The supply pipes should be large enough to insure full supply to the motor with gas at the minimum pressure of 20 millimetres at the consumer's side of the meter. The fall in the pipe should be towards the meter to facilitate the collection of condensed or entrained moisture.



The Eng. Magazine

FIG. 29. PRESSURE EQUALIZING BULB ON GAS PIPING.

It is well to place on the gas pipe close to the motor, either a pressure-regulating valve or a number of chambers so that the operation of the motor shall not cause any pulsations of pressure in the adjoining pipes. If flame ignition is used for firing a charge in the motor cylinder, the supply pipe for that apparatus should be fitted with a rubber bulb so that the suction of the motor does not interfere with the working of the igniter. Figure 29.

Exhaust.—The exhaust pots are generally placed underground in a conduit as near as possible to the

motor. In cases where special precautions must be taken to silence the noise of the exhaust, in order to avoid complaint from neighbors, multiple exhaust pots may be used or a muffler may be placed at the end of the conduit. All joints should be easily accessible and made solely with asbestos. The exhaust piping must always open freely to the air. It must never be led to a chimney or a sewer or drain. Many accidents might be cited, due solely to this vicious arrangement. The joints of the exhaust piping should permit free expansion without danger of breakage.

Starting Appliances.

A gas engine does not permit of starting with the same facility as a steam engine. Special appliances are necessary. These must be so efficient and so easy of handling that one man may always be able to start the engine without pulling on the fly-wheel, while still keeping the driving belt on the unexcited dynamo or on the idler of the driven shaft.

Among starting devices, English constructors particularly have favored a special pump which permits the introduction into the cylinder of a compressed mixture of air and gas, which is then exploded in order to start the motor. I am not partial to this system, especially for motors exceeding 50 horse power, because it has the disadvantage of submitting parts of the machine which are at rest to the shock of a violent explosion. Furthermore, where the engine is supplied with producer gas this type of pump has not given thorough satisfaction, and thus constructors who have persisted in its use have been compelled to resort to the employment of benzine vapor. The one great advantage which may be invoked in favor of the system is that it permits indefinite repetition of the starting operations, if, for any reason, immediate success has not been secured.

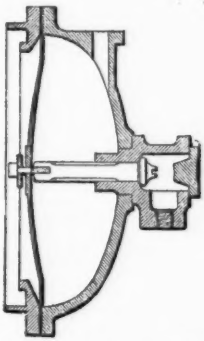


FIG. 30. DIAPHRAGM PRESSURE REGULATOR.

The mode of starting which seems most rational to me is that which depends upon the use of compressed air. For motors of less than 40 horse power the air may be compressed in its reservoir by means of the engine itself at the time of stopping. Above this size it is preferable to use an independent compressor driven by a suitable transmission, which charges the compressed-air reservoir while the

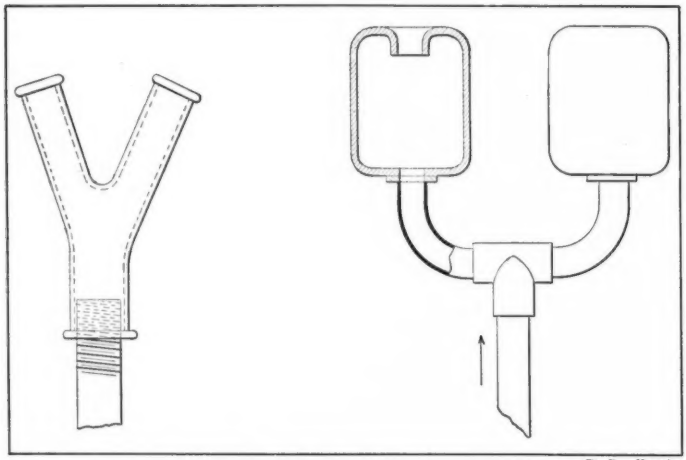


FIG. 31. ARRANGEMENT OF EXHAUST PIPING AND MUFFLERS.

motor is running. Lastly, for installations of 150 to 200 horse power or more, it is well to install a producer driven by a small independent motor using benzine or city gas. The compressed-air tank should be large enough to serve for at least four successive starting operations without allowing the pressure to fall below four atmospheres. It should, of course, be properly fitted with gauges, valves, and cocks. It should be so thoroughly tight that the pressure of the contained air will remain constant for several days. Finally, special precautions should be taken to prevent any entrained oil from passing into the air tank or into the motor, and to subdue excessive noises due to the suction of air by the compressor.

Conclusions.

The points laid down in preceding sections and the details given, whether as to construction or installation, evidently are merely general rules, of which modifications may be made in particular cases according to the special conditions attached to each situation. It is for this reason that I have suggested heretofore in the article, and now emphasize, the necessity of consulting a competent engineer before finally determining the choice of apparatus, and before settling the arrangements relative to its installation.

THE RAILWAYS OF THE UPPER CONGO.

By Demetrius C. Boulger.

There have been some very distressing reports of matters connected with Belgium's exploitation of the Congo. The situation is perhaps too remote and too "opaque" for an inerrant opinion to be formed by the public. Meantime it may be of value as well as interest to study this thoroughly well informed and friendly estimate of Belgian enterprise and achievement in pushing the railway across Africa, from the western coast toward the great north-and-south artery of the Cape-to-Cairo line.—THE EDITORS.

THIRTY years ago the heroic Stanley emerged from Dark Africa, and almost the first declaration that he made about his marvelous discoveries was that he did not value the Congo region at a dollar until and unless a railway connected the ports at the mouth of the river with the navigable portion above the cataracts. That is long ago as the world moves nowadays. But everything that has happened since has confirmed the foresight of the great American-English explorer. The story of railway construction in the Congo State is really a romance that would fill a volume, although railway undertakings are still only in their infancy in the African Continent. It seems to be forgotten by some of our latter-day critics that the Berlin Act, which is so often invoked by persons who have evidently never read it in its entirety, laid down in one of the sections of its first article that the construction of railways was to be undertaken chiefly with the view of abolishing human portage. Although twenty-two years have elapsed since the signature of that Act by fourteen Powers, not one of the five holding territory therein has constructed a single mile of railway in the Congo basin, except the Congo State.

The Congo Government having accepted a clear responsibility in this matter set about devising a regular system for dealing with the question which was the equal concern of the four other territorial powers and itself. It drew up a definite plan of procedure, and in the first stage, considering the limited resources of King Leopold, and the still more limited interest of all outsiders in the situation in Central Africa, it is scarcely surprising that the construction of railways found no place whatever in its original programme. The first point upon which the Congo Government decided to take action was with regard

THE LOCOMOTIVE IN THE JUNGLE.

to the utilisation of water communication on the main stream of the Congo above the cataracts and on its affluents. For that purpose small steamers were sent in section overland to Stanley Pool, where unbroken river communication presented itself for over 800 miles to as far as Stanley Falls. The first of these steamers (and it was a very small one of only 5 tons), was launched on Stanley Pool in December, 1881, three years before the Berlin Conference began its session. During the subsequent twenty-five years the State has been steadily increasing the number and the tonnage of its steamers on the Upper River which today is navigated in a regular manner by a service of steamers of over 500 tons each. But King Leopold had taken good note of the warning of Stanley as well as the provisions of the Berlin Act to which he was in a double sense a signatory, first as King of the Belgians, and secondly, by subsequent adhesion, as

Sovereign of the Congo State. He knew that the railway must come and that only by the railway would his enterprise prosper.

He did not let the grass grow under his feet, once he became ruler of the Congo, for in March, 1887, he granted a concession for the construction of a railway from Matadi, the ocean port on the Lower Congo, to Leopoldville, the river port on Stanley Pool. It would take us too long and too far from our main purpose to describe the construction of this particular line, but no one acquainted with the facts will deny that it was a Titanic achievement carried through under every sort of discouragement. At one stage the project was bankrupt, and outsiders may have rejoiced at the seeming failure of an undertaking which was essential to the foundation of a great Belgian colony in Central Africa. If this project had failed in 1890, as seemed only too likely, there can be no doubt that no matter what vigour and wisdom King Leopold might have displayed in encountering the difficulties before him, they would have proved too great for him in the long run, and complete failure would sooner or later have attended his attempt to found a great national colony. At this critical juncture Belgium came to the aid of its sovereign, and for the first time the personal undertaking assumed a national importance. It was not, however, until 1898, more than eleven years after its inception, that this short line of little more than 225 miles became available for traffic. Students of Central African conditions had fully realised the evils resulting from the employment, often more or less forced, of the African natives as carriers, and the construction of this line with its compulsory portage of the materials necessary for its construction and of the supplies necessary for feeding the men who were building it, brought out the evil in still more glaring colours. But were not these evils inevitable, and the price that had to be paid for a great and highly beneficent result? Let us look to the sequel. Since the construction of what is called the Lower-Congo railway, portage has ceased to be known throughout the whole of the Cataracts Province.

The same difficulty that had presented itself to the pioneers of civilization in the Lower Congo and that had been successfully overcome in the manner described by the construction of the Matadi-Leopoldville railway, confronted the Government in the region of the Upper Congo where navigation was also arrested at more than one point by the presence of cataracts. The first of these obstacles occurred at Stanley Falls near the town of Stanleyville, and above this point portage was the only means of carriage either up stream to Ka-

tanga or across the forest to Mahagi and Lado on the Nile. Yet although it was known that the Upper Congo continued to be navigable for many hundred miles above Stanley Falls, save of course for the distances occupied by the cataracts, nothing could be attempted towards utilising it until the line had been constructed from the port with access to the open sea to the point at which the river became really navigable in Stanley Pool. It was not merely that all available resources were locked up in the construction of that line, but as a matter of fact the requisite machinery and rolling stock for the construction of similar lines in the interior could not be sent forward. Portage was, therefore, the only means of carriage and conveyance available in the Upper Congo, and the application of a solution had to wait its turn. Still every one knew that a better and cheaper means of transport must be obtained.

This has always been the case in virgin territory. In America, the waggon team preceded the Pacific Express, and more recently in British Africa the pioneers in Rhodesia and Uganda were followed by long bands of natives carrying on their shoulders and on their backs the stores and impedimenta of the expedition. The Congo authorities have had to adopt the same means under the same conditions in the vast region subject to their sway. It is necessarily a somewhat harsh method, accompanied with a considerable amount of severity, and no doubt attended occasionally by a certain amount of sickness and mortality. But these consequences are the common accompaniment of the early stages of colonisation in an unexplored and unreclaimed region, no matter what may be the Continent or what the flag under which the advance guard of the colonising or conquering Power moves towards its goal. They are a passing phase, however, as it is clearly to the interest of the ruling State, quite apart from humanitarian motives, to provide as soon as possible a more expeditious, economical and, let me add, popular means of conveyance than the employment of human carriers. No Government could have shown more clearly than the Congo State that it realised that portage was a system to be superseded by something better in the Upper Congo region as quickly and as effectively as had been done in the Lower Congo.

In 1898, the year of the official opening of the line to Stanley Pool, the question entered upon its third stage. Orders were issued for the survey for a railway from Stanleyville to the Nile, and for the preparation of careful reports and charts throwing necessary light on the extent and position of the navigable sections of the

MOVING DIRT FOR CUT AND FILL WORK.

river above Stanley Falls. While these preliminaries were being attended to, the Congo Government devoted its principal efforts to the improvement of its flotilla on the river above Stanley Pool. During these years many 500-ton river steamers and cargo boats of the same tonnage drawn by powerful tugs were placed on the main stream, while repairing slips and dry docks were constructed near Leopoldville on the lake. These details show the thoroughness with which the Congo administration set itself to the task before it. By the time all these arrangements were completed for sending forward expeditiously and cheaply the machinery, implements, and rolling stock needed for the construction of railways at a distance between 1,000 and 1,200 miles from the sea, the plans of the Government had acquired greater clearness and consistency.

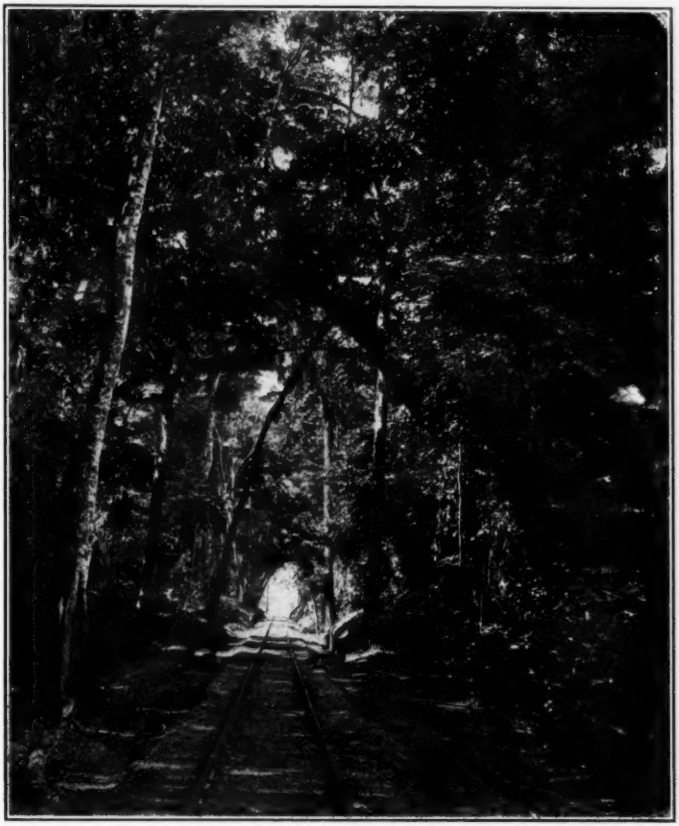
Owing to ulterior considerations of a political order, among

BRIDGE BUILDING ON THE CONGO RAILWAY.

which the unsettled state of the Lado question was not the least important, the surveyed line from Stanleyville to Mahagi was dropped. A definite scheme for filling up the gaps in the river navigation by short lines of railway wherever cataracts intervened was adopted. This plan was decided upon owing to the discovery that except for those gaps the Upper Congo continued to be navigable for many hundred miles, far into the great southern province of Katanga.

In January, 1902, a concession was granted to a company formed specially for the purpose, under the title of "Company of the Railways from the Upper Congo to the Great African Lakes," for constructing lines of railway from the Upper Congo to Lakes Albert and Tanganyika; but this portion of its programme has been left in abeyance pending the execution of its more immediate and necessary task up the Congo River itself. An official decree issued subsequently to its original charter conferred on this company the right and task of building one line to turn the cataracts at Stanley Falls, and a second line to turn the cataracts of Sendwe and Hell's Gate. For the sake of clearness it may be stated that the two lines in question are those from Stanleyville to Ponthierville, and from Kindu to Buli. The first of these lines is completed and in working order. The second line has been begun and is progressing with remarkable rapidity.

The starting point of these railways is Stanleyville, a picturesque and growing town on the left bank of the main Congo river, situated at an altitude of about 1,400 feet above sea level. The first half of the line rises steadily and slowly to a maximum altitude of 1,750 feet. The second half is an equally gradual descent to Ponthierville which is less than 1,550 feet above sea level. Except for this very small ascent and descent the construction of the railway presented no features of great difficulty. As, however, the track passes through a dense forest, it was not easy to determine which was the best line to follow. The clearing of the forest has been accomplished for a very few yards only on each side of the rails. Certainly the most



A CHARACTERISTIC SECTION OF THE LINE ON THE CONGO RAILWAYS.

serious part of the work was the cutting of the track through the wood and undergrowth owing to the fact that the timber could not be burnt on the spot but had to be carried into the open. A further cause of difficulty was the eradication of the roots and undergrowth, while numerous watercourses required either extensive draining and the construction of culverts, or, at certain points, the building of bridges. However, none of these last named was of any important dimensions. Out of the twenty constructed only ten exceeded 50 yards in length. The embankment part of the undertaking also was easily accomplished owing to the absence of rock and to the fact that plenty of earth, including good clay and rubble, was available.

PULLING A STEEL BRIDGE INTO PLACE.

One of the most interesting subjects in connection with this enterprise was the organization of the necessary labour. It must be remembered that the labour was taken from the local people and not imported. Consequently they had no experience of railway construction, although some of the men had become proficient masons and bricklayers on works at Stanleyville which included a very fine and substantially built quay on the river bank. The Belgians organised their labourers into small parties of between 20 and 30 and entrusted the control of each group to a "nyampara" which in this case may be translated foreman. Over every hundred labourers was placed an European foreman. With regard to the payment of the

men, the first experiment of paying them by piece work failed. It was also found impossible to employ them on extra work, for they could not understand that to obtain the extra payment they had to do extra work. It was found that under personal supervision they worked well, but with the supervision withdrawn they did not work at all. In consequence a fixed weekly wage had to be adopted. On this point I do not think better evidence can be given than by an American gentleman, Mr. William Edgar Geil, who made a very interesting tour in Central Africa in 1905 which is described in his work entitled "A Yankee in Pigmy Land," published last year. The following passages I quote from his volume: . . . .

> "While in construction of the 'chemin de fer du Congo' certainly hundreds have lost their lives, and I have no doubt thousands, yet in the long run it will prove to be of great value in saving human life. It is also a great saving of human health. The old caravan route was flanked with the graves of carriers and of whites who fell by the way, and diseases were developed by the journey. Now many sufferings are avoided. Before the railway was opened the journey took twenty days at a cost of £50. There is now a great saving of time and the trip costs only £2. This is a prodigious saving, and with regard to the Great Lakes' railway it is not only a great material help, but also furnishes a new idea to the whole native mind; not simply to those living in proximity to the line, but to millions of natives that have heard rumours of this strange mode of transportation. A gentleman on the spot told me that the history of the whole Upper Congo is divided into two parts, that before the building of the railroad and that since.
>
> "With regard to the works of the Great Lakes' railway, 2,300 native workmen are employed and but 30 whites. The savages receive from four to twelve yards of cloth per month, besides rations of a pound of rice per diem, two pounds of American salt beef per week, a half pound of salt per week, with bananas as often as the Government is able to furnish them or the blacks are able to steal them. They also receive one shoka per week. Now the shoka is the local spear-shaped iron currency of the region. With this they can purchase manioc or some of the little but terrible delicacies so dear to the native heart. The employees work from 6 to 11 in the morning and from 2 to 5.30 in the afternoon. Besides the unskilled labourers there are five coast carpenters and ten masons come from Sierra Leone and Accra. I carefully scrutinized the native employees, and found them strong, robust and jolly. Each wears a medal bearing his number, making it possible easily to trace an individual. These decorated savages wear considerably more clothing than the general run of natives. Indeed they impressed me as being prosperous and well satisfied with their employers, their employment and their wages."

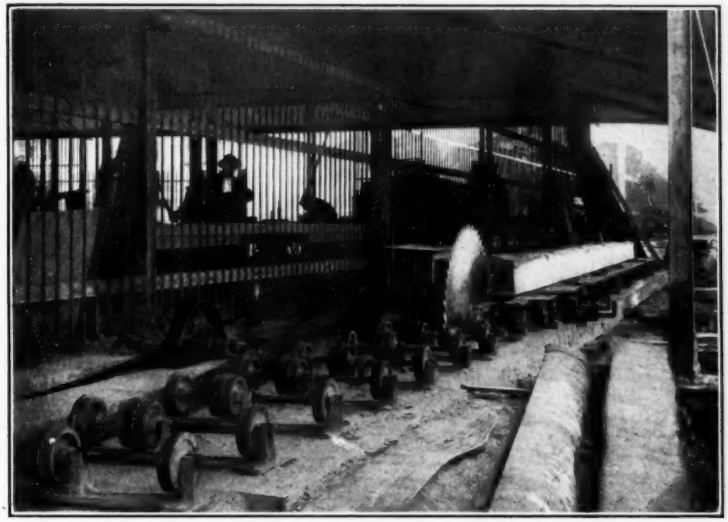
Mr. Geil speaks of 2,300 natives being employed on the works, but in the final stage of the enterprise, which was not reached until a

year after his visit, this total had risen to 4,000. When a large number of men are thus brought together within what may be termed a contracted area it is not uncommon to have an epidemic of some kind or other, but during the three years of active work no serious sickness prevailed, and the mortality was very low. Among the Europeans it was slightly higher, and out of a total of 292 white men—engineers, overseers, etc.—19 died and 44 were invalided. Something of the good health and good conduct of the black workers must be attributed to the fact that a very large number amongst them were Christians, and consequently more or less civilised and acquainted with the laws of sanitation. To exercise a certain moral supervision over their congregation as well as to provide them with the means of practising their religion a chapel was opened on the line of route, and moved forward with the succeeding stages of the work.

The line from Stanleyville to Ponthierville—a distance of 80 miles—begun in January, 1903, was completed in March, 1906, but the official opening was not celebrated till September 1 of that year. The immediate consequence of this achievement was that steamers, tugs, and cargo boats were sent over the line to Ponthierville and launched on the Upper Congo or Laulaba, which here presents a navigable stretch of 195 miles up stream. After these boats had been floated, and communication by water fully established, the whole personnel, native and European, of the first railway were conveyed to Kindu where the second and more considerable part of their task awaited them. As soon as the work was done at Ponthierville and the means of conveyance provided, the men were despatched without waiting to take part in the ceremonies and functions of the official opening. Indeed, before that date was reached the second railway was well advanced so far at least as organisation at its base went.

The railway south of Kindu was taken in hand under much more favourable conditions than its predecessor. In the first place the native staff, instead of untrained and inexperienced men, was by this composed of seasoned and capable labourers. Their numbers had also been increased. Whereas the Ponthierville line was begun with only 2,000 men that from Kindu has been commenced with a staff of not less than 5,000. The improved means of river navigation have also enabled the authorities to send forward heavier machinery and girders, and this fact has undoubtedly simplified the task before the Belgians above Kindu. Indeed, the very first section out of that place could not otherwise have been constructed, for the line had to be carried over a marsh by a steel viaduct for a distance of 200 yards. This

part of the work has been already finished, and the latest information is to the effect that the embankment work is far advanced, and that the rail head has reached kilometre 30 out of a total of 320 kilometres. Although this line is more than twice as long as that to Ponthierville, it is confidently expected that it will be finished by 1909.



A CONSTRUCTION SHOP ON THE UPPER CONGO.

While these important works on land are in progress a scarcely less important task on the river is in hand. The navigable channel from Ponthierville to Kindu has been greatly improved by the removal of many rocks by dynamite and by the employment of a heavy dredger (sent out from the Scheldt) where the water seemed dangerously shallow for the larger steamers. In the upper section of the river above Buli a hydrographic commission has been working for some time on a survey of the navigable channel of nearly 400 miles above the cataract called Hell's Gate. Some weeks ago this party had reached Lake Kisali, which is situated on the eighth degree of south latitude. The report from the leader of the survey party stated that so far as this point this stretch is the very best navigable channel in the whole course of the river above Leopoldville. It seems probable that a navigable channel will be found through Lake Kisali itself without any difficulty, but before accepting this as a fact it will be necessary to await the full report of the survey. In any case it is

proved that a new route by land and water is being opened up for a distance of not less than 860 miles above Stanley Falls, and already 300 miles of it are open to traffic.

What the Belgians have accomplished with regard to the Congo is that they have supplemented the defects of nature and vanquished the obstacles that rendered navigation on the great river of dubious value. By the railway in the Lower Congo they placed the Upper River in direct communication with the ocean and thereby with the outer world. By the two railways that I have described in this paper they have evaded and turned the obstacles which were assumed to render the river useless as a waterway above Stanley Falls. They have thus ensured the prolongation of the magnificent water route which traverses their territory in its first portion from west to east, and in its second from north to south. It is this that constitutes the real source of the present prosperity and the future and much increasing prosperity of their colony. An important German technical publication, *Stahl und Eisen,* concludes from the achievement that "We Germans have much to learn from the farsighted colonial policy of the Belgians in the matter of ways of communication."

It is rather a remarkable and significant thing to notice how cordially and candidly the Germans are expressing their appreciation of the work done by the Belgians in Central Africa which presents such a striking contrast with the harsh criticism and general depreciation that the same subject receives at the hands of some English critics. I cannot conclude this brief paper in a better way than by quoting another German opinion which appeared in a recent number of the very interesting publication called *Weltwirtschaft*:—

> "This new and glorious stage arrived at by Belgian engineers in the imposing development of ways of communication in the Congo Free State marks a further step towards the suppression of human portage. The Government is aiming at suppressing portage and as it has not been able to do so immediately, it has very wisely endeavoured to abolish this burden on the most congested routes. This is especially the case with the Katanga route. The Katanga, with its rich mineral deposits, its fertile soil, and healthy climate, has every prospect of becoming one of the large centres of European activity. The creation of a steam communication between this region and the sea is wise administrative policy, since it affords the actual commercial movement a possibility of full development without turning away the natives from their usual occupations. Far from becoming human beasts of burden carrying heavy loads on the roads, the natives will continue to work on the fields and mines."

PROFIT MAKING IN SHOP AND FACTORY MANAGEMENT.

By C. U. Carpenter.

VI. METHODS FOR FIXING STANDARD TIMES FOR MANUFACTURING OPERATIONS.

Mr. Carpenter's series began in January, and the five articles heretofore presented discussed, first, the general methods of examining into the condition of any manufacturing business so as to discover the existence of waste and loss and to determine the "sticking points"; second, the nature and the working of the "committee system" of factory administration; third, the reorganization of the designing and drafting departments; fourth, the great importance and value of the tool-room as a source and spring of profitable methods; fifth, the general conditions necessary for manufacturing at minimum cost. The installment now presented covers the most central point in machine-shop management—the effective operation of the tools themselves. A following and supplementary paper in August will show how the methods for determining "standard times" for machining can be adapted to standardizing the assembling of work, and how the times so fixed can be introduced into routine operation in the shop.—THE EDITORS.

ASSUMING that we have determined upon standard shapes and have the proper facilities and men for the forging, hardening and grinding of tools properly, we now come to the consideration of the question of making such experiments as will make it possible to determine with a high degree of accuracy just what the shop ought to be able to accomplish in the way of production with the existing equipment.

The first problem that confronts the factory manager is how to start to make the tests on the bewildering number of pieces used in the manufacture of his particular product. The warning should be issued that unless the work of testing is done systematically much of it will be done without avail and great loss of time will follow.

Classification of Parts.—I have usually found it possible, and strongly advisable, to divide into groups or classifications the parts which are to be manufactured according to these new methods. The first separation which would occur to any one would be that according to the quality of metal used. The second grouping will depend altogether upon the article that is being manufactured. Generally it will be found perfectly practicable to make a second series of classifications depending upon the similarity of design, shape, and mechanical operations necessary. Of course where parts are of the same genus

but of different sizes, this is a comparatively simple proposition; but it will generally be found upon analysis that even a further classification can be made under which these groups can be still reduced by considering, as stated above, design and similarity of operation.

I have in mind one shop which required in the course of building, assembling, and making the machines the production of some 9,000 parts. However, by a thorough system of analysis and classification, it was found possible to group these 9,000 parts into less than 250 classifications. It was thus possible to get a clear idea of what should be accomplished on these 9,000 pieces through the results of the 250 tests made in a thorough manner. While it was probably true that the deductions made from these tests were not in all cases as thorough as would have resulted from individual tests, at the same time this plan simplified a tremendous problem and enabled the concern to get a much quicker start on the right road than if a haphazard method of testing these 9,000 pieces had prevailed.

In studying the question of production in regard to any tool, we must consider not only the efficiency of the machine tool and the cutting tool, but also the time that it takes to set up the job on the machine tool in the first place. It is quite probable that a critical examination of the way of setting up the work usually practised will prove that the method used is capable of alterations which will result in a surprising saving of time. A thoroughly scientific method of setting up the job usually results in a saving of 30 to 50 per cent in the time required by the average workman. It is therefore necessary to study this question at the start, as the test is being made, and prepare a list of instructions giving the different operations required in detail and the length of time that should be taken under ordinary conditions to accomplish this job of setting up. This determination of setting-up time should not be left for future tests, but should be done right at the beginning, for if it is not done then, the chances are it never will be done. It is easier to do it at the time of the test than at any other time.

Again, we must consider the time required to handle the parts, especially if they be small so that they can be clamped in and taken out of the machine tool in the shortest possible space of time. A thorough study of this one problem should be made at this particular period. The importance of this is much greater than is usually apparent, especially on parts of small dimensions.

A short time ago, I noted with particular care a workman operating a lathe on a large number of small pieces in a shop where the

manufacture of small parts prevailed. The machine tool itself was well speeded up and the production was quite rapid. It was an actual fact, however, that the time consumed by the workman in taking out his finished piece and fastening in the machine tool the piece to be worked upon, exceeded by quite an appreciable percentage the actual length of time required for the machine operation of cutting.

While this may to the inexperienced man seem to be insignificant, at the same time the determination of these points is of the greatest value, especially under such conditions as outlined above, because of the fact, as stated before, that "time is what we pay for." Everything possible should be done to cut down that element of time all through the shop processes.

Before starting any tests, care should be taken to see that there is provided a cut meter for measuring the cutting speeds, that the belts are all in good condition, and that the proportion of pulley speeds is carefully checked up. The depth of cut should be very carefully measured, and, as stated before, care should be taken to see that you have tools of uniform character and plenty of them. Even at risk of reiteration, I want to emphasize the importance of this provision being made in advance.

Whatever the condition of your shop and whatever the system of management, it is altogether probable that an expert tester will be absolutely necessary. This man should be one who is totally removed from the influence of the foremen or any of the workmen. He should when possible be placed in some part of the factory where he can work practically unobserved and certainly undisturbed. Wherever his tests are made—specially or in the shop—his reports should be carefully checked up and should be invariably sent to the head office, he being given to understand that he is responsible to the officers alone. The importance of having an expert of this character lies not only in the necessity of securing accurate tests upon which you can depend, but also upon the absolute necessity of training up some man who can properly analyze the possibilities of production, fill out the proper instructions, and be in a position to see, as speed boss, that the men are thoroughly informed as to the methods to be adopted in proving the results which his tests show possible. It is absolutely necessary that you be in a position to demonstrate to your workmen that work *can be done* in the time set for it, by actual demonstration. No one can do this better than this expert tester, and no one would be in a better position to show the workmen how to accomplish the result himself. A man in this position should not only have a high

Practical Table of Cutting Speeds in Lathe Work, on Cast Iron, in Feet per Minute.

Tools to be Reground Every 90 Minutes.

Depth of Cut.	Feed, Inches.	1-Inch Tool.			¾-Inch Tool.			½-Inch Tool.		
		Soft.	Medium.	Hard.	Soft.	Medium.	Hard.	Soft.	Medium.	Hard.
3/32	1/64	226	113	66.0	222	111	65.0	206	103	60.0
	1/32	177	88.4	51.6	169	84.3	49.2	147	73.3	42.8
	1/16	130	64.8	37.8	120	59.8	34.9	97.5	48.8	28.5
	3/32	107	53.5	31.2	97.0	48.5	28.3	76.0	38.0	22.2
	1/8	92.8	46.4	27.1	83.4	41.7	24.4	64.1	32.1	18.7
	3/16	75.7	37.8	22.1	66.4	33.2	19.4	....	....	....
1/8	1/64	205	102	59.8	203	102	59.3	194	97.0	56.7
	1/32	160	85.1	46.8	156	78.2	45.6	138	69.3	40.4
	1/16	118	58.8	34.3	110	55.0	32.0	93.1	46.5	27.2
	3/32	97.0	48.5	28.3	88.8	44.4	25.9	72.1	36.1	21.3
	1/8	84.2	42.1	24.6	76.2	38.1	22.3	41.8	20.9	12.2
	3/16	68.6	34.3	20.0	60.9	30.4	17.8	....	....	....
3/16	1/64	181	90.6	52.9	181	90.6	52.9	182	91.0	53.0
	1/32	142	70.8	41.3	137	68.5	40.0	128	64.0	37.7
	1/16	104	51.9	30.3	97.7	48.9	28.5	86.1	43.1	25.1
	3/32	85.8	42.9	25.0	78.0	39.0	22.8	67.4	33.7	19.6
	1/8	74.3	37.2	21.7	67.5	33.7	19.7	....	....	....
	3/16	60.6	30.3	17.7	54.2	27.1	15.8	....	....	....
1/4	1/64	165	82.3	48.1	167	83.6	48.8	173	86.3	50.4
	1/32	129	64.4	37.5	126	45.4	26.3	81.9	41.0	23.9
	1/16	94.3	47.1	27.5	90.8	63.2	36.9	122	61.0	35.7
	3/32	77.8	38.9	22.7	72.7	36.3	21.2	....	....	....
	1/8	67.5	33.7	19.7	62.7	31.3	18.3	....	....	....
	3/16	55.0	27.5	16.1	.....	....	....	....	....	....
3/8	1/64	143	71.5	41.8	150	75.0	43.8	....	....	....
	1/32	112	56.0	32.6	113	56.7	33.1	....	....	....
	1/16	81.9	41.0	23.9	81.0	40.5	23.6	....	....	....
	3/32	67.6	33.8	19.7	65.5	32.7	19.1	....	....	....
	1/8	58.6	29.3	17.1	.....	....	....	....	....	....
	3/16	57.5	28.7	16.8	.....	....	....	....	....	....
1/2	1/64	132	66.2	38.6	.....	....	....	....	....	....
	1/32	104	51.6	30.2	.....	....	....	....	....	....
	1/16	75.8	37.9	22.1	.....	....	....	....	....	....
	3/32	62.6	31.3	18.3	.....	....	....	....	....	....
	1/8	54.2	27.1	15.8	.....	....	....	....	....	....
	3/16	44.2	22.1	12.9	.....	....	....	....	....	....

degree of ability as a mechanic, but should also possess a goodly amount of tact.

TABLE OF PLANER SPEEDS ON BESSEMER PLATES.

Planer Number.	Speed in Feet. Cut.	Return.	Feed on Different Thicknesses of Plates in Inches. 1	¾	½	⅜
1—(82)	19	77	.06	.09	.12	.18
2—(767)	30	97	.03	.045	.06	.09
3—(793)	30	88	.03	.045	.06	.09
4—(96)	22	45	.05	.075	.1	.15
5—(107)	22	45	.05	.075	.1	.15
6—(98)	28	52	.036	.055	.062	.11

Tool to be ground at the end of one hour and thirty minutes on the Bessemer plates.

The tables presented on pages 586-589 show the best results, to my knowledge, to be obtained on first-class machine tools, such as lathes,* planers, shapers, drilling machines. Without some such standard guide, the proposition of making a series of standard-time tests in the ordinary factory is indeed a very difficult one. The results shown in the tables may not in all points prove to be the limit as far as production is concerned; but they represent the best so far obtained, and are far in excess of those usually secured, so that they can be safely used as a basis upon which to work and they make the determination of the best time in which a job should be done a comparatively simple matter, as concerns the machine work alone. Inasmuch, however, as they were obtained under first-class conditions, the state of the existing machinery in the average shop will render a modification of these rules and tables quite necessary. It is for this reason that the investigation of existing machinery (referred to in the preceding article) must be undertaken first, and the tabulations so modified as to apply to the existing circumstances.

By the use of tables on lathe work similar to those prepared by Mr. Taylor, I have been enabled in several cases to make large reductions in the force of machine hands. In one instance several years ago, the introduction of a speed boss skilled in the use of these data resulted in cutting down a machine force of 63 men to 22 men within a period of 3½ weeks. In another case, a reduction of over

* The data on lathe work represent the result of experiments made by Mr. F. W. Taylor and his associates and were presented before the American Society of Mechanical Engineers in his paper on the Art of Cutting Metals. The data are presented with Mr. Taylor's consent and are the most comprehensive and valuable of any so far presented to the manufacturing public, to my knowledge. The data confirm throughout in a very striking manner the experiments performed in factories under my direction. They are, however, more complete than the tests made under my supervision.

Our tests on lathes, planers, punches and dies were made with both the Novo high-speed steel of Herman Boker, N. Y., and the Bohler new rapid steel of Houghton and Richards, Cleveland, Ohio, from both of which we have secured most excellent and uniform results. The drilling data were compiled from a series of tests made in our own shops with drills manufactured by the George H. Rich Manufacturing Co., Buchanan, Mich. The tests on planing and drilling tools were made under the direct supervision of the factory manager of the Herring-Hall-Marvin Safe Co., Mr. E. E. Watson.

PRACTICAL TABLE OF CUTTING SPEEDS IN LATHE WORK, ON STEEL, IN FEET PER MINUTE.
TOOLS TO BE REGROUND EVERY 90 MINUTES.

Depth of Cut in Inches.	Feed in Inches.	1-Inch Tool.			¾-Inch Tool.			½-Inch Tool.		
		Soft.	Medium.	Hard.	Soft.	Medium.	Hard.	Soft.	Medium.	Hard.
3/32	1/64	490	245	111	482	241	110	445	223	101
	1/32	339	169	77.0	323	161	73.4	281	141	63.9
	1/16	235	117	53.4	217	108	49.3	177	88.7	40.2
	3/32	189	94.5	43.0	172	85.8	39.0	135	67.4	30.7
1/8	1/64	427	214	97	423	212	96.1	404	202	91.8
	1/32	296	148	67.2	284	142	64.5	255	128	57.9
	1/16	205	102	46.6	190	95.2	43.2	161	81	36.6
	3/32	165	83.0	37.5	151	75.3	34.2	....	....	....
	1/8	142	71.0	32.3	128	63.8	29.0	....	....	....
3/16	1/64	358	179	81.3	358	179	81.4	359	179	81.6
	1/32	247	124	56.1	240	120	54.5	226	113	51.4
	1/16	171	85.5	38.8	161	80.5	36.6	....	....	....
	3/32	138	69.0	31.3	127	63.7	28.7	....	....	....
	1/8	118	59.0	26.8	...	....	....	....	....	....
	3/16	95.0	47.5	21.6	...	....	....	....	....	....
1/4	1/64	315	157	71.6	320	160	72.7	330	165	25.0
	1/32	218	109	49.5	215	107	48.8	....	....	....
	1/16	150	75	34.1	144	72	32.7	....	....	....
	3/32	121	60.5	27.5	...	....	....	....	....	....
	1/8	104	52	23.6	...	....	....	....	....	....
3/8	1/64	263	132	59.8	276	138	62.7	....	....	....
	1/32	182	91.0	41.4	185	92.4	42.0	....	....	....
	1/16	126	62.8	28.5	...	....	....	....	....	....
	3/32	101	50.6	23.0	...	....	....	....	....	....
1/2	1/64	232	116	52.7	...	....	....	....	....	....
	1/32	161	80.5	36.6	...	....	....	....	....	....
	1/16	111	55.7	25.3	...	....	....	....	....	....

50 per cent in a large machining department was secured within 5 weeks of the time these tables had been placed in the hands of an efficient foreman and measures taken to see that stock was furnished to his machines promptly. In another case a simple system of using the tables made it possible to reduce the number of planers from 19 to 13. Even with this reduction, the remaining 13 planers gave a much larger output than had formerly been secured from 19.

TABLE OF SPEEDS AND FEEDS ON DRILLS.

Size, Inches.	Speed.	Feed.
1/4	430	.018
5/8	330	.019
3/4	280	.019
7/8	255	.019
1	250	.020
1 1/8	245	.020
1 1/4	240	.020
1 3/8	230	.020
1 1/2	210	.020
1 5/8	200	.020
1 3/4	195	.020
1 7/8	190	.020
2	180	.020

Tests made in shops of Herring-Hall-Marvin Safe Company upon cast iron, using drills manufactured by Rich Manufacturing Company, Buchanan, Mich.

A systematic use of the tables on the drilling machines produced even more surprising results. In several cases within my own experience a reduction in prices of over 50 per cent was made possible, and in one particular case a reduction of even 75 per cent.

Of course the possibilities of saving in any one shop would depend upon the production conditions existing at the time the tests and examinations were made, but it is safe to say that large economies will result if such tables can be put in effective use in a manufacturing shop.

I have brought out previously the importance of classifying all of the manufactured parts so that attention can be concentrated upon those which are truly representative of each separate classification. And in determining the best place of attack in the classification it is well to remember that, in the average shop, there is usually at least one point which, through bad equipment or ineffective direction, is practically retarding shop progress throughout. With ordinary foremanship it is almost impossible to discover the existence of such conditions. The Tool Room Committee and the tester, who is destined to become later the speed boss, should therefore first determine the classifications and the best point of attack. After time calculations have been made and approved by the Committee, with the aid of the tables

just given, they should be placed on record cards (which will be considered later) to be confirmed by the tester in actual trials.

It is important, however, to note that in the manufacture of either single large pieces or many small parts, there are a number of elements entering into the cost of production, other than that of machining, which are always of sufficient importance to merit the closest consideration. In fact, very often it is the lack of attention to these other factors that accounts for much lost time. This is particularly the case where large quantities of small parts are manufactured, each part in itself requiring but a slight machining operation.

Almost without exception the tables which have been so far presented represent machining of rather large bodies, while in many cases in actual manufacture the problem is one of the turning out of product of small dimensions. The question of "handling time" in this case becomes of paramount importance. This brings us at once to a consideration of the following requirements, all of which must be considered by the committee, whether the pieces or the quantity be large or small:

1.—There must be ample stock delivered to the workman before he stops work upon his preceding job. This is an item of practice which will in itself bring surprisingly large returns in efficient production. In fact, if nothing more were accomplished than the constant supplying of the workman with plenty of stock, under a good routing system, and plenty of good tools of standard shape and properly hardened, the efficiency of the average shop would be increased probably 33 1/3 per cent. This question will be dealt with later, but reference may be made to my articles upon stock system routing and stock tracing—in which particular emphasis is laid upon the stock tracer, his work, and his authority—and upon inspection, etc., in THE ENGINEERING MAGAZINE, May, June, 1902.

2.—The stock must be so placed as to be most easily reached or handled by the workman. This presupposes a *standard place* for the stock. In the case of large, heavy pieces, standard handling devices must be provided.

3.—The clamping devices must be simple, effective, and *standard*, and must be supplied to the workman before he is ready to start. Much study may be given profitably to this point.

4.—The tools must be *standard* in every respect, ground to proper shapes, and must be supplied to the workman before he is ready to start his work.

5.—The jigs, fixtures, punches, dies, gauges, etc., must be so de-

signed as to be handled easily, quickly, and accurately, and must be at the workman's side before he is ready to begin work upon his new job. Much profitable study can be given to the question of proper tools. These tools and gauges must be inspected for accuracy regularly so that the foreman and workman may have full confidence in them.

6.—All stock coming into a department from some other department *must be inspected* before it is placed upon the department platform. Whether the work is large or small, inspection is absolutely necessary. For further details on this matter it may prove of interest to note the rather full treatment of the subject of inspection in my articles appearing in THE ENGINEERING MAGAZINE in 1902.

Full mention is made of these requirements at this point for, while some of them are far removed from the single problem of machining, they still form a most vital part of the "time required to complete a job," and most certainly no "standard" or "shortest" time can ever be reached unless they are considered and *standard methods* in each case installed. And again they must be considered when we attempt to set a "standard time" upon assembling jobs.

ANALYSIS OF TIME REQUIRED.

Granting that these six requirements have been fulfilled, we next come to the consideration of:

1.—The time required to handle the part or parts.

2.—The time required to "set up" the job.

3.—The time required to machine the work (to gauge or drawing).

4.—The time required to remove the work.

In making any study of the time required on these different parts of a job, an accurate stop watch should be used. One with two hands, either of which may be stopped while the other continues to run, is the best type. It is especially valuable in noting the time required for some particular portion of the work itself, by stopping one of the hands and then noting the actual time lost between the essential portions of the operations as shown by the elapsed time indicated by the stoppage of the other hand. This is particularly useful in noting the operations of assembling. Some uniform tabulation in recording experiments or conclusions should be used from the start. The records submitted are suggestive only, but contain the essential points. The proper forms must be evolved for each case. Features non-essential in one concern may be very important in another; e. g., "setting up," a job which in some types of manufacturing may be

relatively important, while in others it is a very simple one. The same statement can be made with especial emphasis in regard to machining, particularly as regards the production of stock on automatic machines, such as screw machines, or semi-automatics, such as turret lathes.

The time required to handle the parts is an important consideration, whether the tool be a lathe, planer, mill, punch press, or drill press. An astonishingly large proportion of lost time can be attributed to lack of proper facilities for handling work, lack of methods in handling it, and the tendency of the workman to kill time during the period which offers so good an opportunity. In the case of heavy work it will always pay to have good hoisting and handling facilities over each tool. They may take the form of compressed-air hoists or an overhead single track carrying an electric hoist serving a number of machines—a very economical arrangement. In some cases the use of specially designed magnetic hoists will greatly facilitate such work. Close attention should be paid to the clamping devices, so that little time will be lost in attaching to or loosening from the part. A carefully considered and *standard method* of piling or placing the parts will often enable this clamping to be done very quickly.

In the handling of light work there are several points of importance that must be considered.

Wherever possible the stock should be carried in boxes. These boxes should be standardized so that as few sizes as possible need be used. They should contain tin pockets on the side in which the necessary cards can be placed. In many cases it pays to arrange the boxes with movable shelves so that the stock cannot only be easily handled but can be much better protected in carrying it through the shop. Stock requiring close work is often injured through bruising. Again, such a method makes the removal of the stock from the box by both the machine hand and the inspector much simpler.

Careful judgment should be used in selecting the place where the box shall stand. Very often a low, strong table about the height of the ordinary hand truck will be found advisable. The use of this table immediately standardizes the spot where the stock shall be placed, makes it easier for the truckers to handle the boxes, and, in addition to this, saves the work and time of the machine hand in stooping over to pick the parts out of the box. The placing of these boxes in the same position each time—the fact that the workman becomes accustomed to finding his stock always in the same spot—adds appreciably to the speed of handling.

TESTING RECORDS.

Date — Name or No. of Part
Machine Tool — Classification
Cutting Tool — Quality of Metal
No. of parts tested
Setting Up Time (analyzed).

No. of Parts	Handling Time	Depth Cut	Feed	Cutting Speed	Test No.	Time of Test	Condition of Cutting Tool	Condition of Machine Tool	Quality of Work	GENERAL

Standard Time for Setting Up (see instructions)
Standard Time for Handling Parts (see instructions)
Standard Depth of Cut_____
Standard Feed_____
Standard Cutting Speed_____

Note. Tool to be so speeded that cutting tools will require regrinding at end of 1½ hrs. run if limitations of machine tools will permit.

FORM SUITABLE FOR TESTING RECORDS.

In the space beneath this table there can usually be placed an additional shelf to contain the tool boxes for the different jobs which will be apportioned to the workman.

The Determination of Handling Time.—If this rule of carefully standardizing the place before each machine where stock is to be placed is adopted, the question of determining the handling time becomes comparatively simple. A series of stop-watch tests upon a quick-moving workman will usually be found to be sufficiently accurate. It is well, however, to check this up by actual trial on the part of the tester. Full data relative to each test should invariably be placed upon the record cards.

Setting-up Time.—The "setting" up of jobs on lathes, planers, shapers, milling machines, punch presses, drill presses is so varied that no set rules can be laid down relative to it. A close study of all the conditions under each classification of work is very necessary. Tests should be made with stop-watch observations covering each portion of the setting-up job. When this is first attempted, it will be found almost invariably that the clamping devices for the different tools can be very greatly improved.

If the time of the ordinary workman in setting up certain jobs is noted carefully, and then the same jobs are selected for analyses, very surprising differences between the time that he has required and the time that should be required will be found to exist. It being out of the question for any one man to determine the best methods of procedure in the setting up of jobs, it is therefore wise to submit this entire matter to the Tool Room Committee, calling in to such meetings the several foremen and assistant foremen whose departments are affected. The mere fact of calling men in for such important discussions will lead not only to correct conclusions, but will also act as a spur on them toward the improving of the setting-up conditions on the machines in their several departments. In fact, I am in favor of special men to set up work requiring a particular degree of accuracy. This is particularly so in the case of fine punch-press, die, and milling work. A full record of all the analyses of setting up time should be made upon cards at the time of each test.

The Time Required for the Handling of Work on the Machine Tools.—In the case of large work on lathes and planers, the time of handling the work on the machine tool is of minor importance, inasmuch as the work remains fixed until the machining operations are performed upon it. Conditions, however, are different in the case of drill-press work and punch-press work.

The handling of heavy work under a drill press, where a number of holes have to be drilled at different points in the piece of work, becomes quite a problem. Of course, radial drills are in most cases used for such work. In my opinion, however, the average modern radial drill is not built strongly enough to withstand the heavy work which can be secured from a high-grade, high-speed drill if it is pushed to the limit. Better results will be obtained by the construction of a heavy drill press, with stationary overhanging arm, the work to be moved upon a double-acting table having two movements, one at right angles to the other.

Rapid drilling in a shop is very necessary. It is, of course, im-

portant from the standpoint of economy in drilling, but the main feature to be considered is the fact that when work is sent to the drills, nine times out of ten it is then in steady progress of manufacture throughout the shop and under ordinary conditions, some one group of workmen will be found waiting for the drilling operations to be finished. This waiting may not be at all apparent, for the workmen themselves are very careful to conceal any such fact; but undoubtedly much time is lost in the average shop because of lack of high speed in the drilling operations.

Whatever device is adopted for the handling of work, very careful observation should be taken in order to determine the actual time lost in this manner. In punch-press work this handling time becomes even more important, inasmuch as in innumerable cases there are a number of holes to be punched in one plate or strip of metal. A very close study can profitably be made of the proper types of movable tables with indexes and positive stops. In fact, with a carefully designed series of stops for the different classes of work, a great deal of time ordinarily consumed in laying off the holes for punching can be saved. The use of such devices also insures greater accuracy in the punching. Ordinarily, the work of the punch-press operator is not as accurate as it should be, especially on heavy work. Where this inaccuracy exists, it causes an immense amount of trouble throughout the shop.

In the turning out of small parts, the question of handling time becomes of paramount importance. The amount of time consumed, for instance, in placing small work in a drilling jig, clamping the jig, handling the jig, and taking work out, will often be two or even three times the time required to do the actual machining operation. Therefore a close study should be made, first, of the character of these special tools, with a view to reducing to a minimum the handling time of the work and to replacing any tools which require an excessive amount of such time. Granting that the tools are all that they should be, a study of the time that should be taken by an expert workman then becomes important. This can be settled by stop-watch observations and by tests. All data covering such points should be recorded immediately.

Time Required for Machining Operations.—This time can be determined from the tables herewith presented, by the Committee and the tester together with the foremen and assistant foremen of the departments interested. Then this determination of time should be checked up upon each piece representing each classification by actually

trying out the job as an object lesson, if for no other reason. Later, the proper machining time for the parts under each classification can be determined from the tables themselves.

My reason for strongly recommending Committee action in conjunction with the foremen will be discussed later, but a moment's thought at this point will show that this line of procedure will force the obstinate recalcitrant foreman into line in a hurry. He *must* give his support to the line of action. He is helpless as far as opposition is concerned. Furthermore, an improvement in the several departments under each foreman's supervision will become evident almost immediately. I consider this joint Committee action as absolutely necessary to the success of the plan. Always keep in mind that a speed boss or tester will be in a position to *prove* that work can be done within the specified time. Keep in mind however that it is always necessary to correct promptly any errors that may occur and that the workmen can demonstrate do exist.

Time Required to Remove Work from Machine Tools.—If the problem of handling the work originally is properly solved, the further problem of determining the proper time to be taken in removing work will be solved. The same problems of simple and effective clamps and efficient methods of hoisting and lowering work appear here. It is, however, necessary to emphasize the necessity for piling the work on the floor or on platforms in such a manner that it can be easily handled by the moving trucks. In the handling of light work it will often pay to give considerable attention to the problem how best to put the work into the boxes so as to facilitate its handling, to protect it from being marred, to facilitate inspection, and to make it easy for the next operator to handle it promptly. The relative importance of these different operations, however, varies very greatly according to the character of the work. What may be the most important feature of one class of work becomes almost a non-essential in another class.

EFFICIENCY IN THE BURNING OF FUEL UNDER THE STEAM BOILER.

By William D. Ennis.

II. THE REGULATION AND CONTROL OF FURNACE DRAFT.

One of the very significant things in the field of mechanical engineering just now is the wide-spread and eager movement in search of better economy in the boiler room. As Mr. Bolton put it in his series on superheated steam which was concluded in our May issue: "If steam is to retain its place as a method of power development, its whole cycle of operations must come under the definite and concentrated treatment which has been accorded in the past mainly to one end of the operation, viz., the steam-cylinder part of the combination."

Mr. Ennis's discussion which begins in our June issue is therefore as timely as it is thorough. He starts on the solid ground of fact and physical law, and makes perfectly clear what conditions are necessary to the economical burning of coal under the boiler, and what steps should be taken to discover whether these conditions are secured in any given plant, or if not, what remedies should be applied. His articles, which will be continued, will prove of great value to the careful and progressive power-plant manager or owner. The first part discussed the necessities of perfect combustion, and explained the bearings of flue-gas analysis. The section in this issue deals specially with the measurement and control of draft. Next month's installment will discuss the modifications in practical management necessitated by various commercial fuels.—THE EDITORS.

THE reduction of excess air supply, which is the usual direction of improvement in boiler-room practice consequent upon closer study of flue-gas composition, is for practical purposes largely accomplished by a cutting-down of draft. It should be remembered, however, that force of draft and quantity of air supplied are not necessarily interdependent. The hypotheses of Peclet and Rankine recognize that in order to burn coal, the draft pressure must be sufficient to overcome the resistance offered by the coal bed to the passage of air through it. Beds of various kinds of coal offer different resistances to the passage of air; finely divided "slack" or refuse anthracite would seem likely to furnish higher resistance than "lump," "nut" or the graded sizes of anthracite. In practice, it is found that greater draft is required to burn fine anthracite than to burn slack, and greater draft to burn the graded sizes of anthracite than to burn even soft coal, which would certainly impose greater resistance to the passage of air through the fuel bed. It would seem as if a certain intensity of draft were required to break into the texture of the individual particles of coal, this intensity being necessarily greater in the case of hard, tough anthracite than with the more friable soft coals.

The quantity of air required for combustion differs, of course, in accordance with the chemical constitution of the fuel, as indicated below:

Fuel.		Wood.	Oil.	Soft Coal.	Anthracite.	Pure Carbon.
Composition by Weight:	C.....	53	85	73	92	100
" " "	H.....	5	11	6	4	...
" " "	O.....	42	4	21	4	...
Additional O required for	C.....	99	223	174	241	267
O required for	H.....	40	88	48	32	...
N supplied with	O.....	465	1040	744	914	893
Total air supplied.....		704	1351	966	1287	1160

These figures show that nearly twice the air supply is required to consume anthracite that is needed for wood, soft coal requiring about 17 per cent less air than anthracite. These differences certainly do not correspond to the differences in draft required to burn the various fuels. Wood can be burned with one-fourth the draft necessary for anthracite; while the draft necessary for soft coal is certainly not 87 per cent of that necessary for athracite, and oil fuel, although requiring theoretically the maximum amount of air, can be burned with very little draft, so long as the oil particles are finely divided by the atomizing burner. Draft intensity and volume of air supply are therefore not synonymous, although it is usual to control air supply within the limits imposed by the requirements of draft.

That this distinction is ordinarily not recognized is evident from the fact that many engineers who have given special attention to the matter of air supply, have formulated recommendations for economical operation based on an assumed most efficient draft intensity. Thus, in one large plant, it was found that the highest percentage of dioxide, and highest economy, were found with a draft slightly less than 0.2 inch of water. This was with semi-bituminous coal, fired with Roney stokers. Very slight departures from this amount of draft entailed heavy losses in evaporative performance. But it should be remembered that the result as stated is correct only for the specific coal under consideration, as actually fired. For another month's or year's run of coal, or for precisely the same coal, if there were any possible way of duplicating it, hand-fired or fired with some other form of stoker, it would have been found that the best amount of air supply was to be secured at some other draft intensity; perhaps not widely different from 0.2 inch, but still different.

Fortunately, it is possible to obtain, to some extent, independent regulation of the two factors under consideration. After once having

ascertained that draft which is best suited to the physical nature of the coal, we may so control the air supply as to make it most appropriate for the chemical constitution thereof. There is some difference in the formulæ expressing the relation between air velocity and pressure; but if we take as conservative, $P = .0035\ V^2$, in which P is pressure in pounds per square foot and V, velocity in miles per hour, we have for pressure in inches of water and velocity in feet per hour, $p = V^2 \div 48{,}000{,}000{,}000$. Now, if we assume 40 per cent excess air to be the minimum under present conditions, for each pound of coal burned, 16.2 pounds of air must be supplied. Assuming the temperature of the atmosphere to be 60 degrees, the volume of one pound of air is 13.1 cubic feet. The product of 13.1 by 16.2, or 212, gives the cubic feet of air to be supplied per pound of coal. If v represents the velocity of this air in feet per hour, then for every pound of coal burned per hour an area for air passage of $212 \div v$ square feet must be provided. As $v = \sqrt{48{,}000{,}000{,}000\ p}$, the area for air passage, per pound of coal consumed per hour, must be $212 \div 219{,}000\sqrt{p} = .00097 \div \sqrt{p}$. For an average small boiler burning, say, 900 pounds of coal per hour, the necessary air-passage area on this basis would be

$$\frac{.873}{\sqrt{p}}$$

say, for $p = .25$, $= 1.746$ square feet.

This gives areas which are certainly as large as, or larger than, those actually found necessary in practice. Thus, a recent writer reported, with .25 inch of draft at the damper, 900 pounds of low grade soft coal burned per hour with 1.32 square feet of air opening at the ash-pit doors; 14 per cent of dioxide being obtained just after firing and 9 per cent just before firing. These percentages of dioxide correspond to air supplies respectively 135 per cent and 189 per cent of the theoretical; the air volumes being respectively 184,000 cubic feet and 259,000 cubic feet per hour for pure carbon, or for soft coal containing 27 per cent of ash, 111,000 cubic feet and 156,000 cubic feet. For an ash-door opening of 1.32 square feet, the velocities necessary for the passage of these amounts of air are 84,000 and 118,000 feet per minute: whence we have

$$p = v^2 \div 48{,}000{,}000{,}000$$
$$= 0.146 \text{ inch and } 0.296 \text{ inch.}$$

The chimney draft at the damper being only 0.25 inch, that at the ash pit, under any condition of the fire, must be less than .25 inch. If we should make $p = 0.08$ inch and 0.16 inch respectively, as correspond-

ing with 0.25 inch draft at damper for the specified conditions of fire, we would have for the necessary door openings 1.79 and 1.78 square feet in the two cases; so that the regulation of ash-pit door opening in accordance with the figures given is sure to give an ample supply of air.

TABLE 4. AIR SUPPLY FOR VARIOUS DRAFT INTENSITIES.

	Draft at Ash Pit in Inches of Water.						
	.04	.09	.16	.25	.36	.49	.64
	Opening of Ash Pit Doors, in Square Feet.						
Necessary opening for 40 per cent. excess air, per pound of coal burned per hour.....	.00485	.00323	.00243	.00194	.00162	.00139	.00121
Coal per hour, pounds:							
600	2.91	1.94	1.46	1.16	.97	.84	.73
700	3.39	2.26	1.70	1.36	1.13	.97	.85
800	3.88	2.58	1.94	1.55	1.29	1.11	.97
900	4.36	2.91	2.19	1.74	1.46	1.25	1.09
1000	4.85	3.23	2.43	1.94	1.62	1.39	1.21
1100	5.32	3.55	2.67	2.13	1.78	1.53	1.33
1200	5.81	3.87	2.91	2.32	1.94	1.67	1.45
1300	6.30	4.20	3.16	2.51	2.10	1.81	1.58
1400	6.79	4.52	3.40	2.71	2.26	1.95	1.70
1500	7.28	4.84	3.67	2.91	2.43	2.09	1.82
1600	7.77	5.16	3.89	3.10	2.59	2.22	1.94
1800	8.72	5.80	4.37	3.49	2.91	2.50	2.18
2000	9.70	6.45	4.85	3.87	3.24	2.79	2.42
2500	12.1	8.09	6.06	4.84	4.05	3.48	3.03
3000	14.6	9.70	7.29	5.81	4.85	4.17	3.63

Computations by 10-inch slide rule.

Accepting the formula for air-passage area, area $= .00097 \div \cdot\sqrt{p}$, the figures of Table 4 are presented, showing the necessary air-passage areas for various intensities of draft, and amounts of carbon burned per hour. These figures as expressed on Chart 3 may be used for anthracite coal; for soft coal, the openings might theoretically be reduced 17 per cent, were it not for considerations of gas mixture. They show, at least, what is gradually becoming evident, that a very slight amount of opening of ash-pit doors is all that is necessary for reasonable rates of combustion; and that such slight opening is indispensable if the economy is to be high. The formula and curve given may be disputed; in fact, the relation $P = .0035\ V^2$ cannot be said to have been definitely established; but it certainly cannot be disputed that the vast majority of power plants are wasting coal because of ash-pit doors too widely opened.

Nothing has been said regarding the damper. The position of the damper may perhaps not be fixed so entirely from considerations of air supply, as that of the ash-pit door. For one thing, it is more

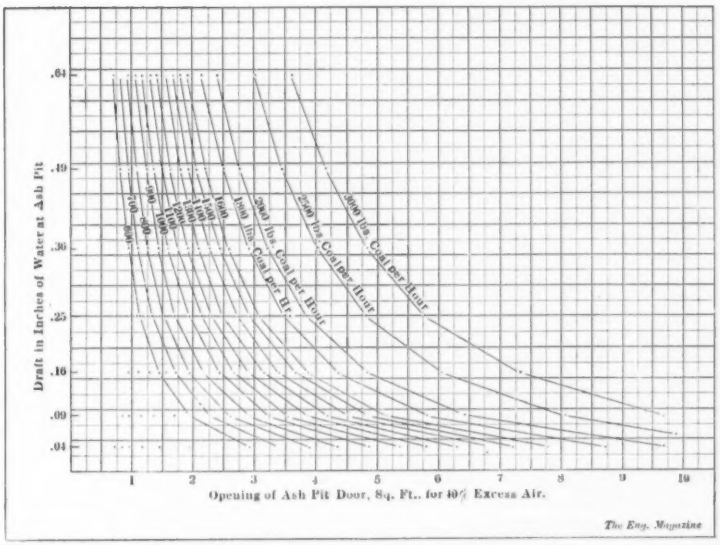


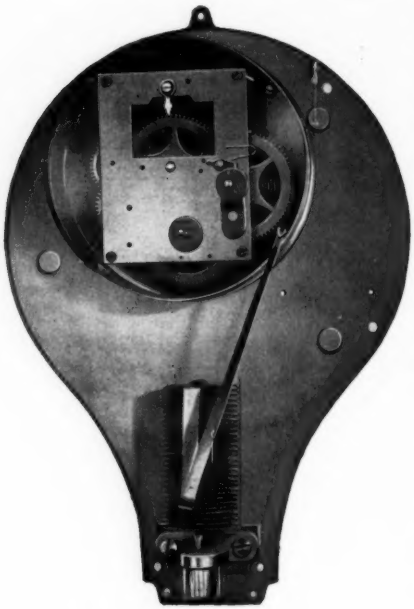
CHART III. RELATION OF AIR OPENING TO INTENSITY OF DRAFT.

difficult to reach and control. If this article shall in any measure have served its purpose, it will most assuredly impress on any power producer the absolute necessity of damper control. The damper should be made as easy and quick to operate and as simple, strong, and durable, as the best engineering design can accomplish. What would we think of a steamship in which the steering gear was located, say, on top of the deck house, accessible only by means of a ladder, sometimes found rusted fast, or covered so that movement was impossible? But the damper constitutes the steering gear of the power plant and is worthy of as important a place and of as much appropriate refinement of construction and operation. At this point we take the first step in the power problem of the day—the checking of draft so as to reduce the excess of air supply.

This does not necessarily point toward damper regulators. In theory, it would necessarily lead to choice of hand regulation. Our object in the boiler room is steam production, not a certain predetermined pressure of steam; that is incidental, or at most an indication that steam production is keeping pace with consumption. Our actual object is to evaporate. Under fixed conditions of design, the production of steam depends upon the rate of feeding the coal, the amount of air supplied, and the condition of the fire. The damper regulator

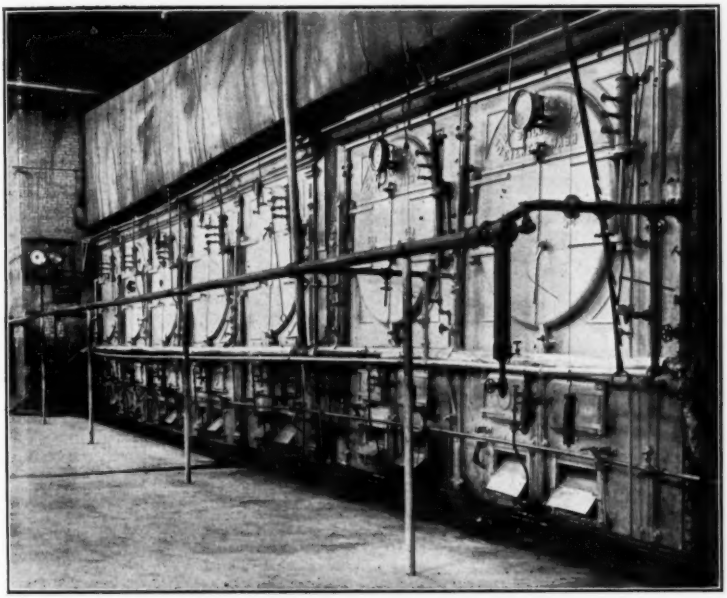
controls but one of these three essential elements, and its control is effective only in consequence of variation in steam pressure, which is not always necessarily due to a variation in steam production requiring correction. We have already referred to the greatly decreased furnace temperature resulting from an excess of air. Suppose that a battery of boilers is under steam and under automatic damper control, and that the pressure begins to fall. The regulator immediately admits more air, which, unless a sufficient amount of coal is at once supplied, will chill the furnace and decrease steam production. The condition of the fire in some of the furnaces may be such that this sudden supply of fuel and air may not be detrimental; but in other of the furnaces it may result in waste.

All progress, however, must be along lines of least resistance; and since the problem of furnace operation is to compel attention to, and control of, the dampers, any mechanical device which simplifies that problem is a benefit. No mechanical device can possibly produce the perfect results that would follow the constant application of human intelligence; but no class of labor has ever yet duplicated the regularity and thoroughness of a machine. Perfect hand-control of dampers would be the best thing, but is impossible of achievement; the next best thing is to supplant hand regulation, so far as is possible, by automatic control. In the case of damper regulators applied to a battery of boilers, this partial control must be supplemented by the exercise of skill and judgment in order that detrimental results may be avoided.



BRISTOL RECORDING DRAFT GAUGE.

For pressures below 4 lb. a still more sensitive form is made reading between 0 and 2 lb. A tube from the nipple at the bottom leads to the chimney or flue, the recording instrument being placed anywhere, at convenience.
The Bristol Co., N. Y.

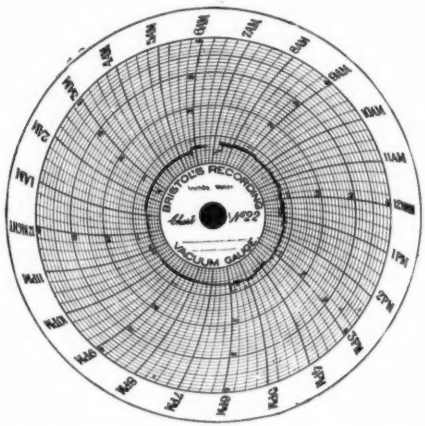


AN OIL-BURNING BOILER PLANT WITH SENSITIVE DAMPER CONTROL.

In this plant, under Mr. Ennis's management, a battery of old horizontal boilers were worked up to an efficiency of 83 per cent, while driven 30 to 50 per cent beyond their rating. The sensitive dampers on the ash pits were "home-made." They were unusually wide open when the picture was taken.

Ideal control would be that which would maintain uniform condition of fires in all the boilers of the battery; an adjustment of the rate of coal feeding, and a corresponding adjustment of air supply. These requirements would appear necessarily to involve some form of mechanical stoker; and the best results in power production on a large scale are no doubt secured where stokers are employed with the highest class of skilled attendance and supervision. Those forms of stoker which are driven by independent steam engines or motors lend themselves readily to regulation of feed. Stokers should not be started and stopped so as to produce intermittent combustion averaging so as to correspond with the load requirement; but the speed of feed should be nicely adjusted in accordance with the variations in requirements for steam. The hand regulation of the dampers should be facilitated by making the control levers easy of access and of operation, with plainly cut notches to determine and indicate the amount

of opening, and an accurate draft gauge located in a conspicuous position where its reading will be evident at a glance. The time may come when it will be possible to replace the draft gauge by a direct measurement of air supply, so that the rate of feeding both fuel and air may be indicated at each moment. With such devices, and a cheap, portable form of carbon-dioxide indicator, all located immediately over the front furnace doors, it would seem as if a very close approach should be made to ideal combustion.



RECORD MADE WITH A RECORDING DRAFT GAUGE.

Bristol recording gauge, at the power plant of the B. F. Goodrich Co., Akron, Ohio. Natural draft.

It is the practice in very large steam plants to maintain a number of reserve boilers over banked fires at all times. This is to minimize risks from breakdown which would throw boilers out of service, and also to take care of variations in load. At first sight it would seem as if such a mode of operation were necessarily highly wasteful of fuel. As a matter of fact, however, it is found that even the large stand-by losses consequent upon this practice are less than those involved in forcing the boilers with intensified draft to a point where the air supply becomes excessive beyond comparatively low limits. This furnishes an extreme illustration of the wastefulness of operation when an excess of air is permitted.

THE INTERCHANGE OF HEAT IN STEAM-ENGINE CYLINDERS.

By W. F. Cleveland.

THE theory of the interchange of heat between the working steam at its varying degrees of pressure, humidity, and temperature, and the internal surfaces of the cylinder walls and pistons, has been the subject of much controversial discussion; but its corollary of condensation losses, however fallaciously deduced, is generally accepted as the method by which these losses—the most serious of all in the application of steam power—are sustained. It seems strange, however, that the theory has not been subjected to more rigorous adverse criticism, as there are abundant facts relating to the action of heat under other but analogous conditions which cannot be harmonized therewith, and when properly submitted as evidence are simply overwhelming in the conclusion to which they point—that the theory as applied is a false one, or true only to an insignificant extent as the basis of trifling losses.

Objections to the theory have been raised on the ground of the inadequacy of the time afforded during a fraction of the piston stroke, when passing the point of release, where the losses are said to be chiefly incurred; but in presenting this argument a proper association of the facts relating to the action of the heat under common and familiar conditions seems to have been neglected. At three hundred revolutions per minute, or for locomotive engines with six-foot drivers a speed of a trifle over sixty miles per hour, the entire stroke of the piston is covered in one-tenth part of a second, but during the first and a portion of the second quarters, according to the location of the cut-off, the absorption of heat by the metal surfaces from the entering steam must first take place; and as there is little space for expansion earlier than the point of half stroke, the out-flow of heat must necessarily occur during the latter half-stroke, or at most in one-twentieth part of a second. If, as is claimed, the losses occur chiefly when passing the point of release, the time must be still further reduced to perhaps the fiftieth part of a second.

If, in this discussion, we were concerned with electric instead of

thermal currents, the importance or bearing of the element of time could not be so intelligibly considered. A naked finger may with impunity be quite slowly passed through a gas flame, but no sane experimentalist would approach a "live wire" with a similar intention. The flesh of the human body is a good conductor of heat, and the temperature of a gas flame is many times greater than that of steam, as used in locomotive boilers; but the significance of these facts may be still further emphasized by varying the experiment by the use of a common friction match or strips of paper, which may be slowly passed through the flame without ignition. The sensation occasioned by a single passage of a finger through the flame is very slight, but although the surrounding atmosphere has the cooling effect of air currents afforded by the alternate passage of the finger through it, there is a gradual accumulation of heat which becomes unbearable at the nail after about thirty-five passages. Matches and small rolls of paper ignite in about the same time. These facts cannot be harmonized with a theory based on the assumption of the rapid flow of heat currents.

In a standard locomotive cylinder using 180 pounds initial pressure, there is a range of temperature, between admission and exhaust of about 139 degrees, the falling temperature accompanying the pressure, at the point of cut-off, in its gradual descent throughout the expansion curve, but dropping suddenly in unison at the point of release, where the heat stored in the surfaces of the cylinder walls and piston is said to be suddenly transferred in the minute fraction of a second to the escaping steam, and lost in the exhaust. The figures given represent the difference between the steam-chest and the average exhaust temperatures, but without the use of some auxiliary valve attachment, for separating the initial from the final exhaust (an experimental device of extremely difficult application) the lowest cylinder temperatures cannot be recorded by the use of thermometers. Under the assumption that extremely variable and constant pressures are governed by a constant ratio of temperature, the steam indicator may afford the desired information. It is therefore assumed that a rapid outflow of heat takes place, similar to that occasioned by the sudden plunging of red-hot metal into cold water; but everyone is familiar with the fact that heat will not flow so rapidly, even in such an experiment, as small strips of heated metal may be suddenly immersed and withdrawn, say in one-quarter of a second of time, with but little change of temperature. The prolonged sizzling of small pieces of heated metal when thrown into cold water affords additional

evidence of the moderate flow of heat currents, even when induced by a great range of temperature, and a heat-absorbing agent of enormous capacity. Simple experiments in physics with which every school boy is familiar, like the illustration of the flow of heat through metal rods, by the dropping of balls of wax, adhesively suspended at successive intervals from the point of heat contact, have imparted lessons which seem to have been utterly ignored in the application of this theory.

A law of heat on which the economy of steam boilers is based permits the flow of heat from iron to water, or aqueous vapor, much more readily than the reversal of the current, and imposes another difficulty in the way of the acceptance of this theory. If it were an equally reversible law, the losses by radiation from steam boilers would be far more serious. The enormous temperatures of the furnace and fire tubes force the heat into the iron sheets, from which it much more readily flows into the water; but the resistance to a reversal of the current at the outer shell of the boiler is an important factor in the maintainance of its efficiency. Heat will flow from iron much more readily than it will flow into it, a fact that may be verified (in connection with the previously cited experiments) by the sudden immersion and withdrawal of thin strips of cold metal from a pot of molten iron, when the change of temperature will be found almost imperceptible. Such strips of metal are but slowly fusible, when thrown into the molten iron.

If the metal surfaces of the internal parts of the cylinder are robbed of their heat during the period of initial exhaust, their restorage must take place during admission, and the time is therefore almost equally limited; but if the flow of thermal currents into metal surfaces is so slow under analogous conditions, and with such enormous ranges of temperature, the conclusion is inevitable that the internal surfaces of the cylinder parts, already raised to the temperature of boiling water, cannot absorb from steam at a fraction of the temperature of molten iron, or communicate thereto, a much greater volume of heat in a fraction of the time.

In order to avoid the branding of the theory as self-evidently absurd, it must be contended that only a very thin shell of the internal surfaces, say to the extent of five or ten pounds of iron, is thus subjected to changes of temperature; but under this assumption another difficulty is encountered in the limited volume of heat units that could be absorbed and discharged within the claimed fraction of the total range of temperature of 139 degrees. At the average speeds of

modern locomotive engines, there are no scientific instruments capable of determining, with any degree of reliability, what this fraction may be; but it is certain that it is infinitesimal. The indications of such instruments, in tests that have been attempted, were undoubtedly occasioned by the variations in the temperature of the working steam itself. Such changes of temperature in the metal surfaces, moreover, although we may suppose them to be extremely thin, would induce serious expansion and contraction, and in a short time result in crystallization and crumbling of the parts exposed to their action.

The galvanometer as applied by M. Armand Duchesne, of the University of Liège, in recent experiments, is an instrument actuated by thermo-electric impulse. That actual heat absorption and discharge to any appreciable extent, by the silver and platinum couples of the instrument, is necessary for the production of such impulses, cannot be demonstrated. If such absorption and discharge were the only principle involved, nothing short of complete action throughout the full range of temperature would insure an accurate record. There is evidently some subtle molecular action occasioned in the couples by the changes in the temperature in the working steam, the character of which is as little known as the real nature of electricity. When, therefore, the distinguished experimentalist placed his couples within one millimetre of the internal cylinder surface, he simply interposed an additional resistance, not taken into account in the preliminary calibration or graduation of the instrument, which satisfactorily explains the reduction in the recorded temperatures. The couples themselves, as placed in the clearance spaces, were subjected to precisely the same thermal action as the cylinder walls, and if the record they conveyed had been one of heat changes in the couples, instead of heat changes in the working steam, it would also have been true of the temperature changes in the cylinder walls, except for the allowance that should be made for the inferior conductivity of cast iron.

In these experiments it was found that, near the close of compression, the thin film of steam between the cylinder and piston heads, in spite of the unfavorable length of the time of exposure to heat absorption by the proportionately large enclosing surfaces, still attained a point about 145 degrees higher than initial temperature. And yet it is contended that the serious losses of initial condensation are occasioned through heat absorption by these same metal surfaces. Why should the greater weight of admission steam communicate a greater volume of heat when its temperature is so much lower? Of course there is a slight increase of surface, due to the movement of

the piston, but inadequate as such an explanation would be, it is the only one apparent but it is not advanced, although the contention embodies an evident contradiction, with changes of temperature in the metal surfaces, as the basis of the theory. If such heat absorption by the metal surfaces were a possibility, the filling of the clearance spaces by compression with anything but water would be an impossibility. Superheating of saturated steam in such a confined space as the clearances of a steam-engine cylinder, without a corresponding rise of pressure, indicates a concentration, chiefly, of latent heat, and affords additional evidence of the baleful character of the products of compression, in the standard cylinder.

The superior economy of four-valved engines has been largely attributed to the alleged losses occasioned in single-valved engines by the passage of the exhaust through the live-steam channels, and to absorption thereby of heat from their surfaces, although the high revolutionary speeds of the latter class of engines, if the theory is to be logically considered, should afford a much more efficient protection from such losses, in their more restricted time of exposure to exhaust temperatures. If the theory were a sound one, the economic performances of these engines should be reversed, unless it should also be contended that the losses sustained by the cooling of the passages exceed those incurred by the cooling of the cylinder and piston surfaces. The admission passages in both types are filled, during exhaust, with the same material that is being discharged from the cylinder; but in four-valved engines the outlet is at the bottom of the cylinder, permitting the water of condensation to be blown therefrom with the aid of its own gravity. This seems a more reasonable explanation of the gain in economy than that afforded by the passage-cooling theory, which is advanced as a deduction from the interchange-of-heat theory.

It is contended that the water of condensation and vapor in the working steam flashes into true steam with the sudden reduction in pressure at the point of release, the implication being that with the corresponding drop in temperature that ensues at the same instant, an out-flow of heat from the metal surfaces is induced thereby; but the fact that this very change transforms the absorbing agent from the strongest to the weakest of conductors, is not advanced as a factor in the argument. The boiling point of water, within certain limits, is dependent upon the pressure, but at the point of release the volume of heat units to be discharged cannot act upon the water of condensation, within the cylinder spaces, unless there is an instantaneous or

free expansion instead of a prolonged discharge of the exhaust. The immediate effect of such re-evaporation would be the complete drying of the cylinder walls and spaces, but the standard cylinder is unable to free itself from the aqueous residue of the exhaust, which condenses upon its walls, filling the space before the piston, and is swept into the clearance spaces, where it is re-charged with heat from the entering steam, to be followed by the endless repetition of wasteful discharge at the point of release. That metal surfaces continually subjected to the action of water under such conditions, in the course of a few revolutions would reach and retain an average temperature, dominated by that of the water with which they are sprayed, partakes strongly of the character of a self-evident truth. It is the water of condensation, acting directly upon the entering steam, that is the real agent of these so-called interchange-of-heat losses, although, properly speaking, there is no interchange of heat; it is merely absorption during admission and discharge during exhaust. The enormous heat-absorbing capacity of aqueous vapor is well-known, but this baleful characteristic is aggravated, by the facility afforded for its action, in the thorough mixture of the products of compression with the entering steam.

In the standard cylinder, the measurable temperature of the internal surfaces never rises much above that of boiling water, and cannot do so until through the motive agent, either before or after admission, means are applied for keeping them dry, a fact that is being recognized in the progressive use of superheaters. In compound and multiple-expansion cylinders, heat absorption by the aqueous elements is largely avoided by the restriction of the ranges of temperature in the successive cylinders, but the advantages of the system are difficult of application to locomotives. The value of free or instantaneous expansion of the exhaust, previous to discharge, in cylinders designed for the purpose, has been little understood or appreciated, although the transformation that may be effected in the character of the working steam by its use has been clearly demonstrated in recent experiments, which will become better known in the future. The practical application of the principle will open a new and interesting field in steam engineering. Under the restricted conditions of locomotive-cylinder construction it is of especial value, as the demands upon the locomotive for greater power, especially in the propulsion of heavy trains at the excessive speeds of modern railway travel, cannot be satisfactorily met, even by balanced compounds, with their unwieldy complication of reciprocating parts.

HYDRO-ELECTRIC POWER VERSUS STEAM FOR INDUSTRIAL PLANTS.

By H. von Schon.

IV. THE ENGINEERING STUDY OF A WATER-POWER PROJECT.

With this article, Mr. von Schon brings to conclusion his series which began in THE ENGINEERING MAGAZINE for April last. The preceding parts have taken up consecutively the general comparison of hydro-electric and steam installations as to cost, efficiency and reliability; the commercial study of a water-power project; and the description of some typical stations of widely differing types, with a list of opportunities waiting development.—THE EDITORS.

IN a preceding article of this series, the hydro-electric power project was considered as a commercial enterprise. The important factors, by the careful consideration of which a reliable conclusion as to the paying qualities of the project can be reached, were pointed out, and it was found that the burden of supplying the necessary data on these points fall upon the engineer. As has been shown, the analysis of a hydro-electric power project involves principles of topographical, hydraulic, mechanical and electrical engineering and, for this reason, the projection, design and construction of hydro-electric power plants form a distinct engineering specialty. From the first step in the necessary investigations to the last, the topographical, hydraulic, mechanical and electrical elements of the problem are so intimately connected and interdependent that an incorrect judgment of the proper application of the principles of any one is likely to render the final conclusions more or less erroneous.

It is only rarely that conditions are such that the most satisfactory site and scheme of development can be determined by a merely cursory examination. It generally becomes necessary to study carefully a considerable reach of the water-course to determine the best location, and the selection of the latter depends largely on a correct understanding of topography of the river valley and of its geological character. Such knowledge could be gained by means of extensive surveys and borings but the time and cost involved in such operations are not generally available in original exploitation of this character. The information must be gleaned, rather, from a general reconnaissance during which the topography and geology become pictured, so to speak, upon a mind which is trained to estimate the influence of their characteristics on the project under consideration. The experi-

enced observer will instinctively distinguish the advàntageous from the objectionable features and by a process of elimination will readily recognize the best obtainable locations for the development site and the equally important storage reservoirs.

The location selected, the scheme of development has next to be determined, and this problem may be solved in any of three ways, by direct development, by short, or by distant diversion. The determination of the available flow must first be made and this involves besides a consideration of the topographical and geological features of the drainage area, an examination into the general climatic conditions of the region and the application of hydraulic principles. It is not always desirable to concentrate a fall exceeding 25 to 30 feet at one place, as the cost and weight of a dam increases very rapidly above that height, and the enlargement of the flowage area, consequent on the building of a high dam, may necessitate the purchase of costly lands. It is, therefore, worthy of study whether the available fall may not be more economically obtained by the diversion of part of the flow into a canal, when the flow is large, or into a flume or pipes when the flow is small. Consideration of the topographical and geological features of the region must decide this question: a convenient side hill or plateau may offer a suitable location for conduits and, with high heads, a pressure line is generally the solution; and occasionally a sharp bend, detour, or ox-bow, so-called, of the river channel offers an opportunity to carry a part of the flow across the intervening peninsula, through a tunnel in case the land rises too high for other diversion methods. The comparative costs of direct development at a dam and of development by diversion must be balanced, due weight being given in the consideration of the latter case, to the probable loss of head and the effect of evaporation, leakage and ice on the volume of flow in open conduits. The general development scheme determines the location of the power station.

The design of the works proper, so as to secure safety, permanency and high efficiency, with maximum economy in first cost, maintenance and operation, involves the application of many of the important principles of civil, hydraulic, and mechanical engineering. In alluvial locations, the planning of economical yet safe foundations and cut-offs will frequently tax the most experienced. The successful designing of works for the harnessing of the power of a stream can be accomplished only when accurate data as to the extreme conditions to be expected in flood time are to be had. The large majority of failures of dam structures are due to one cause, namely, the underestimating of the flood flow and neglect to provide adequate discharge

section and cut-off safeguards. The solutions of these problems, do not lie on the surface but are revealed only to him who knows where and how to search for the truth and who possesses the ability and courage to form an opinion only on the merits of the case. Only too often the investigator permits himself to be influenced by enthusiasm, of his own creating or born of suggestion, which leads him to belittle difficulties and to exaggerate advantages. In such a frame of mind, even if competent, under ordinary circumstances, to form a correct estimate, he absolutely lacks the firmness to obey the dictates of his better judgment, because perchance this would render the project less desirable if not absolutely unfeasible. Some stern critics might call this downright dishonesty, but it is generally due to a lack of courage to stand by one's convictions or to inability to recognize the full extent of possibilities.

The designing of power equipment goes hand in hand with that of the works, as the design of the latter, at least that of the power station, is based upon equipment requirements. This calls for the application of mechanical and electrical knowledge. It is lamentably true that the extent of such designing very often consists only of reference to trade catalogues. If that is sufficient, the work does not require an engineer at all. Any manufacturer will probably honestly advise that such and such of his particular output is absolutely the best for the purpose and he certainly cannot be expected to urge the use of that of his competitor. The engineer herein referred to as competent to report on a hydro-electric project, designs the equipment himself, or, at least, he is competent to review the design of any turbine, governor, generator, exciter, or other machine, to determine whether it is capable of rendering the intended service.

It is the purpose of the foregoing to outline clearly the professional equipment which must be at the command of the engineer from whom may be expected a report of a hydro-electric project on which it will be entirely safe to base the commercial enterprise, to fix upon the capital investment, purchase lands, sell securities and close contracts for power service. No title nor degree nor association membership can guarantee such equipment in the man who affixes it to his name. Evidence of experience in this specialty, of reports rendered of plants designed and constructed under the responsible charge of the engineer, of a reputation for competency, and of absolute conservatism is the evidence to be looked for. There is a certain practice which, though calculated to lead to failure more frequently than not, is nevertheless rather general: that is, to secure a man to make a report on a contingent fee

arrangement. I repeat that this practice generally leads to failure, because no such engineer as has been described can be engaged on such terms and when incompetency and unscrupulousness go into partnership the result can be readily foretold. As business men begin to realize more keenly the commercial value of every undeveloped water power, large or small, far or near, they will also find ways and means to remove their exploitation from the class of speculative enterprises. Supposing a company were organized for the business of insuring the works of a hydro-electric plant; it can hardly be said to represent a greater risk than a ship at sea; no policy would certainly be obtainable for a plant excepting upon the O. K. of a competent authority, and furthermore no hydro-electric project could be financed without such a policy being attached to the report. This is merely a thought, possibly original with the author, if so, it is offered for what it represents, but if this seed takes root anywhere I shall be glad to assist in nursing it to fruition.

In giving a necessarily very brief outline of hydro-electric engineering, the sole purpose is to present the essential features in the examination of hydro-electric projects and their correct treatment, in such a manner that the information may prove useful to the industrial promoter, the operator, and the investor, when applied as a rule by which the value of the conclusions, and thus of the commercial merit of the project, may be measured.

The functions of water power are flow and fall. The flow which is said to be available for development is properly called the "potential flow." All stream flow owes its origin to precipitation, except in extreme northern latitudes where rivers are still fed by glaciers. Of the falling rain, a portion is absorbed by vegetation and the remainder sinks into the ground. Only when the ground is saturated, or the fall is too great to be all taken up by the soil, does a portion remain on or flow off the surface. The disposition of snow, whenever it liquifies, is the same. The water absorbed by vegetation is converted into cellular fibre or is exhaled and vaporized, and vaporization carries off also a part of the water remaining on the surface or collected in lakes and swamps. The portion which enters the soil replenishes the great reservoir of ground storage, from which a constant supply is fed to vegetation and the remainder escapes to the stream valleys, in obedience to gravity, as rapidly as the permeability of the material through which it must pass, permits. The division of precipitation disposal among vegetation, ground-storage and surface run-off depends upon the topography, geology and climate of the drainage area, the latter comprising all the area finally contributing

to the stream in question. The part absorbed by vegetation and vaporized makes up evaporation and the remainder is the run-off, the sum of the two making up the precipitation volume. The portion of precipitation chargeable to evaporation depends upon vegetation and climatic conditions, while the ratio of surface flow to run-off is fixed by the topography and character of the surface material.

A drainage basin which yields, in proportion to its area, the largest potential flow, is that in which evaporation and surface flow are a small portion of precipitation and the greater part of rainfall is absorbed by ground storage and regularly and constantly fed to the stream. Such a drainage area is characterized by a cover of deep drift of sand and permeable soil, and by a flat or light rolling surface with large swamp areas shaded by timber or brush. The opposite is an area of cultivated or grazing lands of hilly surface with rock at or near the top of the soil. In the former, only the excessively heavy rainfalls materially increase stream flow which is subject to only moderate fluctuations; in the latter, the stream rises rapidly with each rainfall, subsides with equal rapidity and continues to decrease in flow until the next rainfall. The river basins of northern Michigan, Wisconsin and Minnesota illustrate the former, and those of the Southern and Western rivers the latter. The stream systems of New England, New York and Pennsylvania rank between.

From extensive investigations of the amount of evaporation it is known that from 15 to 35 per cent of the annual precipitation remains available as run-off, and therefore the monthly run-off, were the total evenly distributed, cannot exceed one-twelfth of this, or from 1.25 to 3 per cent of the annual precipitation. Even this portion, as a matter of fact, cannot be accepted as the correct potential flow, which must be sought rather from the low than from the high monthly run-off. It is known that in northern latitudes on well controlled drainage basins, the low run-off for about 3 months, generally in the fall of the year, is from one-half to one-third of the theoretical mean monthly run-off, or 1.5 to 1.25 per cent of the annual precipitation. For eastern systems the value is from 1 to 0.75 per cent, for southern, from 0.25 to 0.12 per cent, and for western, from 0.16 to 0.1 per cent. Thus, with an annual rainfall of 40 inches,

the	low	monthly	run-off	of	northern	rivers	is	about	0.55	inch
"	"	"	"	"	eastern	"	"	"	0.3	"
"	"	"	"	"	southern	"	"	"	0.15	"
"	"	"	"	"	western	"	"	"	0.1	"

This represents the theoretical depth over the entire area, and this value may be translated into flow expressed in cubic feet per

second per square mile of drainage area, by multiplying the depth of run-off expressed in inches and decimals by 2,323,200 (cubic feet on one square mile corresponding to one inch in depth) and dividing the product by 2,592,000 (seconds in one month). Thus the monthly run-off of 0.3 inch equals a continuous flow of $0.3 \times 2{,}323{,}200 \div 2{,}592{,}000$ or 0.27 cubic feet per second per square mile. If the drainage area contains 1,000 square miles, the low monthly flow under these conditions would be 270 cubic feet per second. If no storage reservoirs are available, from which this low monthly flow can be added to, this represents the continuous potential flow on which the development must be based unless the low flow output is to be raised by an auxiliary plant. Given the drainage area and the annual precipitation, an approximation of the potential flow, which will generally err on the safe side, can be readily obtained in this manner.

The closest determination of a stream's flow is secured by measurement of the various stages from low to high and compiling from the results a rating table which will show the flow corresponding to any stage. The measurements required for this purpose must extend over several years and are best made by gauging the overflow over a weir, or, if this is impracticable, the flow over a spillway with horizontal crest. Mill dams, if tight, afford fair opportunities for flow measurements by gauging the overflow daily and computing the flow, which equals, approximately

$$L \times 3.33\, h^{\frac{3}{2}}$$

L being the length of overfall in feet, and h the height of overfall in feet, the result being cubic feet of flow per second. When no such dams exist and the stream is too large to erect a measuring weir, the flow passing a fixed section must be measured. The section must be regular in shape and not subject to changes, and the measurements must cover the total range of the various stages of the river. Such measurements can be made with specially adapted instruments or with floats, but the use of any of them requires experience gained by practice, as indeed does the entire process of flow determination.

The possibilities of storing a part of the high flow for distribution during low stages must be thoroughly determined, as the desideratum lies in the utilization of the greatest portion of the annual flow. Tributaries emptying above the power site frequently present such opportunities, especially when they flow out of lakes. In this connection the evaporation from storage reservoirs must not be lost sight of, as during midsummer it will be as high as 5 or 6 inches per month.

When the monthly flow during a dry year has been found by any

of these methods, it yet remains to be determined what is to be accepted as the basis of development, because the flow will probably vary from three cubic feet per second per square mile of drainage area during the spring, to one-tenth of a cubic foot or less during the fall or winter. As a rule, there are three months of well marked low flow, not always, however, in sequence; when one low month occurs between two higher, it is probable that the flow can be raised from storage, if any is available, to that of the other two. This may even be practicable with two or three low months in sequence, preceded and followed by a high month. The determination of available flow, or potential flow on which development is to be based, must be deduced from a consideration of all these possibilities. The character of the market demands may also enter into this discussion, as the loads in summer are smaller on the lighting and higher on traction service, than during the winter months. Finally, the applicability of a reserve auxiliary power plant must be considered and, if its installation is found to be advisable, the permissible output of such a plant must be fixed by comparison of the increased cost due to its operation with the price which can be obtained for the output. Thus, step by step, all these factors entering into the determination of the scope of development must receive due weight, in order to arrive at that decision which will represent the most economical, or rather remunerative, utilization of the available flow.

Much less intricate is the determination of available fall. The total fall in the stream over the reach to be controlled by the development is ascertained from levels, which should be returned to the starting point in order to insure against error. The concentration of this entire fall at one point or its diversion will depend upon the conditions pointing to the location of the development works, while the recommendable program will determine whether all or only a portion of it can be utilized.

When potential flow and fall have been settled upon the capacity of the development can be at once deduced by dividing the flow in cubic feet per second by 12½ and multiplying the quotient by the height of the useful fall in feet; in other words, each 12½ cubic feet per second of flow will yield one effective electrical horse power with each foot of the fall, in which rule turbines and generators are credited with practical working efficiencies. If the water is to be diverted in open channels or conduits a proper deduction must be made from the available fall for loss while thus diverted, as the flow of water is due to fall.

The mapping out of the development programme must be based

upon all the foregoing conditions, the volume of flow, height of fall, the formation of river valley, bed and banks, character of sub-surface material, flood rise of stream, winter conditions, and the accessibility of works for the purpose of delivering construction material and equipment. The simplest arrangement consists of the concentration of all the fall at one point by closing the stream valley to the required height by a dam and placing the power station at one end or within the dam; or a portion of the fall may be thus accumulated by a dam and the flow diverted to a point lower down stream, the power house being placed at the terminal of such diversion. In cases of high falls, the dam may be placed at the uppermost end, merely acting as a diverting medium, while the water is taken through pipes or conduits to the foot of the fall. The diversion need not follow the river but can often find a much shorter route from head to foot of fall. It is readily conceivable that there are few occasions where conditions point at once infallibly to one of these programmes as the best. They must all be studied and compared and considerable planning and estimating are necessary in order to determine the best scheme of development.

The principal feature of a water-power plant is the dam. This is generally a composite structure consisting of a spillway, that portion over which the flow not utilized for development is to escape, and the dam proper which must rise above the greatest flood height. If the river banks are vertical rock walls rising above the height of the future upper level, then a spillway only is needed, but, as conditions are generally found, a portion of the valley also must be closed by a dam structure. The length of the spillway should be determined to pass the flood flow within a fixed height. This is computed from the discharge over weirs already referred to. In addition, other means of water escape must be provided, such as waste weirs or flumes, the latter being arranged near the base of the structure to permit of the lowering of the upper pool, so that the dam may be examined and repaired.

The choice of structural type should be guided by conditions of bed, volume of flood flow, availability of construction material, and height required. When the bed is of rock, the problem is greatly simplified, but when of alluvial formation it forms one of the most serious of the entire undertaking. Timber dams are not to be recommended on account of their perishableness, as the cost of maintaining them becomes a constantly growing charge, while the necessity of their renewal is a question only of time. Masonry dams are readily planned and constructed to guarantee safety and permanency but

are the most expensive type, especially for alluvial locations. Concrete dams are equally safe and permanent but open to the same objection in soft river bottoms. Concrete-steel dams of the gravity type are the latest developed designs and combine safety, permanency and economy of first cost, while they are equally suitable for rock or soft locations. In rivers which are subject to high floods, the ideal type is a structure which affords the least obstruction to the passage of the flow, or which is in part movable, consisting of masonry or concrete piers, with gates or needles which can be readily operated. Concrete-steel gravity dams also largely fulfill this condition because of the opportunities to pass through them waste flumes, operated from the interior of the spillway. An arrangement should be provided on all dams by which the upper pool can be raised a few feet for the purpose of accumulation of flow during periods of non-operation.

The spillway terminates in abutments, to which is joined the reservoir dam. The latter structure may be of earth fill with masonry or concrete core wall, or of concrete-steel bulkheads. One of the most important structural features of spillway and dam lies in the absolute necessity of cutting off all underwash or scour, which, in alluvial river beds, can be accomplished only by penetration into impermeable material. This cut-off may be a sheet curtain of timber or steel piles, provided no boulders are imbedded in the material through which the piles are driven. If the former are present, no sheet pile construction will avail. The cut-off must be, in this case, a concrete wall.

Next to the dam comes the canal or conduit, if the program includes diversion. When the flow is small an open canal is not recommendable because of the impossibility of making it water-tight except by expensive construction, while the loss from evaporation and, in northern latitudes, from ice, will be an appreciable percentage of the total flow. Timber flumes, wooden-stave, steel or concrete pipes are available for this purpose, their use depending upon the volume to be diverted and the location which can be secured. When canals are planned they must conform in form and size of section and slope of bed to well established hydraulic principles. The slopes of the banks, when long, must be broken by berms to prevent destruction from rains and surface run-off, and permanency is best secured by paving these with stone. The flow in unprotected alluvial channels should not exceed three feet per second, as the transporting force due to a greater velocity will move sand and small gravel. The intake to a diversion canal or conduit should be arranged to control the inflow and exclude floatage. Timber flumes should not be larger than the

size required to pass the normal flow, so that the complete saturation of all parts of the lining is insured and early decay prevented. They must be securely and firmly bedded on sills and compacted material to maintain rigidity of shape as originally constructed and to prevent opening of the joints; the top should be covered to protect against the sun and cold.

Pipe lines must be planned in accordance with hydraulic principles, proper allowance being made for losses at entry and by friction, not only that of the new pipe but the rapidly increasing friction as the pipe ages. Wooden-stave conduits constructed of redwood, when properly built and kept filled with water, have proven quite as durable as steel pipe, are less costly, and develop less friction. For high pressures, exceeding 200 feet, only steel pipes are available, and the thickness of their plates and details of sectional construction must be carefully designed to guarantee safety. Concrete-steel pipes have been employed of late for this purpose with varying success, but they are not safe under pressures exceeding 50 feet. Location, curvature and anchorage of pipe lines are all-important problems requiring careful design.

The power station is the final and most important part of the plant. Here the water is passed in some manner through the turbines and back into the stream. The power station is located at the terminal of the diversion or at the dam, and the design depends, as to general arrangement, upon height of available fall, while the output fixes the dimensions. Up to a certain limit of fall, about 35 feet, turbines are economically placed in open chambers into which the water enters directly from the upper pool. In this case turbines are said to be drowned and are mounted on draft chests. For higher heads turbines are housed in metal cases, the water being fed to them through pipes. For either plan the station building requires a substructure called the pit and a superstructure in which the turbines are placed. The arrangement of the electric generators depends upon the installation of the turbines in a horizontal or in a vertical position and the connection desired between each turbine and generator, which may be direct or by gears. The structure may be of masonry, concrete or concrete-steel. The foundation requires the same careful treatment as that of the dam, the substructure must be heavy, while the super-structure may be comparatively light. Every part of the station should be readily accessible, pit and turbine chamber so arranged that they can be unwatered, and ample space should be provided to handle conveniently equipment for the purpose of installation and repairs.

The power equipment can be determined only after the units of output have been chosen and the latter must be based upon market requirements and hydraulic conditions. Generally speaking the units should be as large as permissible in output and they should be uniform. Where the entire output goes to one market, the whole capacity may be divided among equal units of such characteristics of power and speed as are representative of the most economical standard apparatus. These power and speed characteristics are determined from the volume of water, head, turbine capacities, and speed and adaptability of generators. When the output is to be sent to more than one destination, the requirements of each enter into the question.

The reaction turbine meets the requirements of heads up to 80 feet, and beyond that point the impulse wheel or a type composed of elements of both forms of equipment. Low-speed turbines require large and costly generators if direct coupled, and if geared some losses are incurred. Whether the turbine unit is to consist of one or more wheels is to be decided by a comparison of the respective costs of the complete hydraulic and electric power unit and its housing necessary for each arrangement. After the question of power units is settled the character of the equipment can be determined, that is of the turbines and governors, generators and exciter units, switchboard panels and cable conduits, which items practically complete the generating plant.

The current is to be delivered at a distant point, and for this a transmission line is required. How far can you carry electric current and what will be the loss during transit, is a frequent question. The limit of distance and of loss is purely a question of cost; current is now being sent over continuous lines of 300 miles and longer. While there are many conditions to be considered, it may be taken as a general rule that there should be 100 horse power to be transmitted for each mile of line, and the loss in transit can, in this case, be kept below 10 per cent. This question of loss is to be solved mainly by a consideration of the cost of copper and the value of the delivered current.

At the terminal of the transmission line a substation must be provided to receive the current. When the output is sold in bulk, this substation completes the plant, but where it is to be distributed it may be necessary to transform it to lower voltage, and convert it into direct current since the transmission from generating plant to substation is of alternating current only.

The cost of the works and equipment, and therefore of the output, depends upon many conditions and these can be given proper

consideration in the preparation of an estimate only by a person who is competent to analyze them fully and to appreciate the value of their influence. The estimate should quote the unit costs of material, operations, and equipment upon which they are based. In other words, costs should be given in detail for each part of the work instead of lump sums for dam, canal, power house and equipment.

The cost of the dam should contain the item of "control of flow" during construction, which may require diversion of the stream, coffer dam and pumping. Dam foundations should be detailed as to excavation, bearing and sheet piles, cut-off wall and concrete. Timber piles cost from 25 to 35 cents per linear foot driven; timber sheet piles from 35 to 50 cents per linear foot, and steel sheet piles from 80 cents to $1.50 per linear foot; excavation of soft material 25 cents and of rock from 75 cents to $1.00 per cubic yard; masonry in dam from $8.00 to $12.00 per cubic yard, concrete from $7.00 to $10.00, and concrete-steel from $8.00 to $15.00. Reinforcing steel costs from 3 to 4 cents per pound and structural steel erected from $80.00 to $100.00 per ton. Turbines cost from $5.00 to $10.00 per mechanical horse power and turbine governors from $300.00 to $500.00. Generators cost from $10.00 to $12.00, transformers from $4.00 to $6.00 per kilowatt, and exciters $20.00. Switchboard panels cost from $250.00 to $400.00 equipped. Poles for line, 35 feet long, cost from $2.00 to $3.00 set, and 65 feet long, from $18.00 to $22.00. Cross arms cost from 40 to 60 cents, and insulators 35 to 75 cents. Copper wire at present costs about 26 cents per pound. To the total estimate should be added 10 per cent for expenses of engineering and inspection and a like amount for incidentals. Having found the cost of output, the value of lands, right of way, franchises, etc., must be added, and the total amount will be the investment required.

When all these data are collected the commercial prospect of the enterprise can be determined by grouping the fixed charges of interest on capital investment, sinking fund, operation, maintenance, depreciation and taxes on one side and probable receipts from current sales on the other. The apparent surplus will tell the story.

Generally speaking, an investment of from $160.00 to $180.00 per horse power delivered will show a net earning capacity of 6 to 8 per cent. These are rather high cost figures. The large majority of hydro-electric developments range between $125.00 and $150.00 per horse power and are therefore capable of a commensurate increase in net returns. The value of these investments is, however, more likely to increase than otherwise, since every indication points to a rise in the price of power service in all branches of industry.

EDITORIAL COMMENT

THE new Catskill Mountain water system for enlarged supply to the city of New York is in many respects, and probably in net total, the most interesting work of engineering construction now under way—and since the ceremonial opening on June 20 it may with all technical propriety be said to be "under way." The stage of careful study and able planning and preparation gives place formally to the stage of physical construction.

The undertaking has not, perhaps, the avoirdupois of the Panama Canal, but it has finer, more complex and more original problems than those of the greater waterway. And it is peculiarly a product of civilization, the necessity which demands this huge enterprise—an outcome of the concentration of a swarming population within the confines of a limited city, to which the prime requisites of life must be supplied and distributed by draft upon the open spaces of country still uncovered. The acres of the mountain and the meadow must continue to supply food, water, and clothing to each individual, but to the dweller in towns they must be brought by an elaborate scheme of transportation, and no part of the whole system appeals quite so strongly to the imagination as that which makes the mountain stream run to the very inmost lodgings of the heated town. Nine hundred square miles of hill country, open to the sky, to gather the supply; a reservoir twelve square miles in area to store it; a hundred and fifty miles of huge aqueduct to bring it to the householders of one great city; a filter plant larger than any yet constructed to purify it—these are only a few elements in the scheme which has been worked out so swiftly and so harmoniously that most of the people were scarcely conscious of the preparations, though they contemplate measures which surpass all precedent in engineering achievement.

A marked characteristic of the dedication ceremonies was the sincerity, the apparent strength of serious purpose, the confidence, and the buoyant enthusiasm of all who took part. Whether among those who have guided, those who have designed, or those who are executing the work, or among the participants in and guests at the ceremonies, the same temper was everywhere. It was a fine demonstration of the spirit of public enterprise conceived and executed in honesty and ability. The difficult work of the officials responsible for the undertaking is mostly done, and well done. Much of the difficult work of the engineer also is finished. And if the execution of the plans brings work yet more difficult, the engineers who have so ably conceived and carried on the project so far will prove amply competent to every emergency.

* * *

IN contrast to this wise conservation of the stores Nature provides, a curious foil is provided by the reported project for reforestation of the Allegheny and Monongahela valleys and tributary watersheds. This indicates a belated, but now startled and thorough, awakening to the criminal folly with which the waste of timber resources has been conducted. The measure suggested is heroic in its proportions; one estimate puts the number of trees required to be set out at 20,000,000, and the waiting period before relief will be afforded at fifteen years. But the loss and damage of the annual flood at Pittsburg and the adjoining cities are enormous and intolerable. Even this huge undertaking

seems desirable, if by reclothing the denuded hillsides, checking the rapidity of the spring thaws, replacing the equalizing sponge of vegetable mould and woodland growth, and retarding the run-off, the violent fluctuations in stream regimen can be modified and the lower valleys protected from sudden flood waves.

So vast an object lesson should not be lost on other regions, but yet history suggests only too clearly that economic lessons have seldom been learned through the experience of others. The forests of the Hudson watershed are going the way of those of the upper Ohio basin, but faster, under the stimulus of higher prices for lumber and new markets for by-products. The bark slasher has been followed by the lumberman, the lumberman by the tie cutter, and the tie cutter by the "acid" maker. And of them all this last is the worst, for he strips the ground of every stick, large or small, regardless of kind or species, and leaves a naked surface behind him from which the rains and the snow runnels wash all fertile soil, leaving a desolation for all time like that of the barrens upturned by the gold dredge. Hesitant as we are to discourage any industry, and especially to see invested capital impaired as to its earnings, we should regard it as a gain to the State and the Nation if denatured alcohol should drive wood alcohol from the market and destroy the incentive for the establishment or the continuance of the "acid factory." In regions which ought to be the wild parks and summer gardens of the thickly settled Eastern States, richly repaid by those who resort to them for health and fresh air, the acid factory is devouring everything by which the country was made beautiful, and leaving nothing by which agriculture can live.

One of the most deplorable symptoms is the indifference to the destruction of assets going on around them which is shown by the residents themselves—the very ones who by agreed sentiment and action might most surely secure reform and protection. The tree has no value to them beyond immediate conversion into lumber or cordwood. Fine young saplings, the future treasury of the nation, or splendid shade trees which an incoming resident population would value at hundreds of dollars for ornament, are felled for firewood, to save the insignificant trouble of selecting trees of less value; wide, hideous, glaring barrens are chopped along the highways to "dry up the road," by commissioners or path masters ignorant of the first principle of road making—drainage; too incompetent even to know that "cutting out" is not only wholly ineffective, but also more costly than ditching. It cannot be expected that they would see the economic evil of stripping whole valley sides of their fine young second growth for the passing profit of a dollar and a half a cord.

It cannot be expected either that owners who by selling, or manufacturers who by buying and stripping the land can make a few dollars an acre, will refrain out of consideration for posterity. The remedy must be found in regulation by the State. Little as we love government intervention, this seems to be a case in which it is desirable—more, necessary. The State alone can act with the requisite power and the proper broad and far-sighted regard for the interests of the citizens of today and of the years to come.

* * *

In the death of Sir Benjamin Baker the world loses one of the greatest masters of constructive engineering of our times. He had the breadth of vision which saw huge problems so clearly that they seemed simple, and a simplicity of soul which carried all his honors without self-consciousness. The world will remember him by the monumental memorials of his work—his friends, by his gentleness of heart.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

INSURANCE OF LABOUR IN GERMANY.

FEATURES OF THE ACCIDENT-COMPENSATION AND OLD-AGE PENSION SYSTEMS OF GERMANY.

Engineering.

IN the April number of THE ENGINEERING MAGAZINE, a review in these columns described certain features of the national system of labour insurance recently established in Italy. Under the Italian system, insurance is effected by the employers of labour in a national fund which is under the direct control of the State. In Germany also accident insurance is compulsory and it is, to a certain extent, regulated by the State; but in general the employers are responsible for the establishment of insurance funds and there is but little governmental interference. The following details of the German system are taken from a recent number of *Engineering*.

The legislation on which the present system is based was passed in 1900. This decree rendered accident insurance compulsory on the part of employers of labour and affects workmen in all classes of industry whose annual wages are 3000 marks (150*l.*) or under. It also covers domestic service and cases of accident which might occur to operatives away from their regular work when they are acting under their employers' orders.

"Although accident insurance is compulsory as aforesaid, and is carried out under State guarantee, the State, so to speak, stands apart, and, although controlling the insurance, does not overburden employers with red tape in the matter of all the minute insurance clauses. The employers of similar trades and crafts have joined together, and have formed district trade insurance associations in the central towns of the districts throughout the country. These are self-managed bodies, who appoint sub-committees and agents, and obtain full reports on each individual case which comes under their jurisdiction. For State work the trade associations are replaced by Government boards for the consideration of cases of accident.

"The law on accidents provides compensation for all cases except those in which the accident was caused by the victim intentionally, the compensation being paid after the first thirteen weeks, during which preliminary period the sufferer is on the sick-list, and receives medical treatment and a part of his wages. If the workman be rendered totally unfit for work as the result of an accident, he receives as a pension two-thirds of his annual wages. For partial disablement the compensation varies according to the consequences of the injuries received. In both cases the patient is given immediate surgical and medical treatment, this continuing as long as is necessary. If the accident causes the death of the workman, his funeral expenses—equal to a fifteenth part of his annual wages, minimum 50 marks (2*l.* 10*s.*)—are paid by the association, the latter further granting to his representatives an annual pension of from 20 to 60 per cent. of the annual wages of the deceased, this being distributed to the widowed consort, to the children under sixteen years of age, to indigent parents, grandparents, and to orphan grandchildren.

The above proportions of the wages, however, are not absolute, and it is within the discretion of the trade insurance associations to increase the pension to the full amount previously earned by the deceased; the same applies occasionally in the case of absolute permanent incapacity for work; while, when unemployment is traceable to the consequence of partial incapacity for work following an accident, the compensation may reach for a time two-thirds of the wages as paid to those who become totally unfit for work.

"The annual wages are taken, under the decree, at 300 times the daily wage. Under former enactments the maximum was 1200 marks (60*l.*); it is now 1500 marks (75*l.*), and all sums exceeding this product are counted, for pension and compensation purposes, at a third their amount.

"During the first thirteen weeks following an accident the operative is cared for by the sick fund, or at the employer's cost. Following this preliminary period, when the operative is being attended to, and his family is receiving aid through the provisions made by the sick fund, he may, subject to the decision of the trade insurance association, remain in the sick club, the said association taking over all medical charges and compensation allowances from the thirteenth week; or the association may take a case in hand from the moment the accident occurs, charging the sick fund with all expenses incurred during the first thirteen weeks.

"The amount of claim is settled without loss of time by the trade insurance association on the evidence of a report made out by the police; when the settlement is likely to be delayed by investigations, the injured workman is paid a sum on account. The time during which a claim for compensation for an injury traceable to an accident may be put forward is two years from the date of the accident. A workman who is not satisfied with the decision given in his case by a trade insurance association can appeal within a month to an arbitration court, formed of two representatives, one selected by each party, a Government official, acting as umpire. This court settles all minor and current disputes. More important decisions may be carried for appeal to the Imperial Insurance Bureau, the head authority which has charge of the labour decree, its operation and matters of jurisdiction connected with it. This consists of a president, appointed for life by the Emperor, and twelve temporary members, of which six are representatives of the Bundesrat (Federal Council), and six representatives of employers and operatives in equal numbers in industry, agriculture and transport. There are also other permanent members of administration appointed by the Emperor, twenty-one for accident insurance and six for disablement insurance; legal advisers, and Government delegates; all of whom form the different committees and courts of equity.

"The amount of contribution of each separate employer of labour towards his trade insurance association is in proportion to the risks which his membership entails upon the association. The risks for each separate establishment are determined on the basis of a danger tariff drawn up by the association, and in proportion to the total wages paid.

"An interesting feature in the decree is that the State does not interfere directly with the question of protective devices and appliances; it acknowledges that it is to the interest of the trade insurance associations to improve these, and always to put down the very best, and has left the decision and jurisdiction as to the selection of such appliances entirely in the hands of the associations. The latter have the power to increase the assessment of those members, being employers of labour, who do not adopt the most perfect appliances in the matter of safety. The associations have also framed rules with regard to safety, and may fine the operatives who transgress these rules. The question of safe working and safety appliances is, however, under the general supervision of technical inspectors appointed by the Imperial Insurance Bureau above referred to.

"The sick fund already alluded to is worked in conjunction with the provisions of the law on accidents. Insurance with the sick fund is compulsory, the workmen contributing two-thirds, and the employers one-third, both calculated in percentage on the wages, the workmen alone participating in the benefits of the fund. These benefits are: medical treatment or free hos-

pital treatment, and sick-pay for thirteen weeks, the sick-pay being half the daily wage, as a minimum; this is increased in special cases. Should an accident prove fatal while a workman is being relieved by the sick fund, his representatives are allowed from the said fund funeral expenses amounting to twenty times the average daily wage. Insurance with the sick fund is compulsory on behalf of the employés and workmen whose annual wage does not exceed 2000 marks (100*l.*). Independent employés, and those whose wages exceed the said limit, are at liberty to insure or not. The sick fund is administered independently of the Government, and is divided into sections in the various districts throughout the country, the divisions covering each the same trade, or the callings in which risks are practically equal. Each section is independent of the other sections of the same district, and of similar sections of other districts. This greatly facilitates management, collection of contributions, and prompt distribution of relief; also the detection of cases of malingering, and the settlement of disputes. The latter are decided, free of cost, by the local courts of justice.

"Besides the sick funds which work in conjunction with the trade insurance associations, and whose awards in the matter of relief to really necessitous families are not infrequently in excess of the limits above stated, there are private sick funds, the membership of which is voluntary.

"In Germany insurance for securing an old-age pension, and for guarding against the effects of physical incapacity, was first governed by a law of 1891, which since has been superseded by that of July, 1899, which came into force in January, 1900. Insurance is compulsory on the part of all inhabitants on completing their sixteenth year, the law covering all employés, whatever be their trade, apprentices, domestic servants, engineers, foremen, clerks, shop assistants, teachers, ships' crews, &c., whose annual wages do not exceed 2000 marks (100*l.*). It is compulsory also on the part of small employers of labour who employ but one assistant workman. Insurance is voluntary on the part of employés whose annual wages are from 2000 to 3000 marks (100*l.* to 150*l.*). The following are exempted from compulsory insurance:—Officials in any way connected with Government, also public school teachers, while training for their profession, if they have expectations of a pension equal to the lowest incapacity and old-age pension; soldiers who during their service are employed as workmen; persons giving instruction for remuneration during their studies; infirm persons who are entitled to an incapacity pension, or whose capacity for work is reduced permanently to less than one-third; persons who, in exchange for their work, receive no wages, but board and lodging, or who can obtain only temporary employment.

"The personal contributions to the fund, if they have been regularly paid for a minimum period of 200 weeks, are reimbursed in cash on application; to the insured female who marries before she is of age to obtain an annuity; to the representatives of a deceased workman; and to operatives permanently disabled by reasons of an accident, and who obtain the accident pension.

"A pension for incapacity is granted to those persons who become unable to earn at least one-third their average wage, after they have contributed to the fund for at least 200 weeks, their altered circumstances being duly ascertained by official inquiries. The old-age pension is granted to all contributors on reaching their seventieth year, after they have contributed to the fund for at least 1200 weeks. To each annuity when it becomes due, whether for incapacity or by reason of old age, Government adds the amount of 50 marks (2*l.* 10*s.*). Government also pays the contributions to the fund of the men while accomplishing military service.

"For the purpose of establishing the amount of individual contributions to the incapacity and old-age pension fund, the wage-earners have been divided into five classes, according to the following total annual wages earned:—350 marks (17*l.* 10s.), 550 marks (27*l.* 10s.), 850 marks (42*l.* 10s.), 1150 marks (57*l.* 10s.), and above. Contribution to the fund, based on these totals, are paid each week, half by the operative and half by the employer. As a general rule, the employer pays the total sum and deducts half from the operative's weekly wage. At the present time,

the total weekly contributions to the fund are as follow, as per the above classes:—14, 20, 24, 30, and 36 pf. (1.68d., 2.40d., 2.88d., 3.60d., and 4.32d.).

"With reference to the working of the incapacity fund in conjunction with the old-age pension, the main point to be borne in mind is that no man can enjoy any two pensions simultaneously. The two insurances are essentially one. If a workman, at whatever age, becomes incapable of work through sickness (during actual sickness he is provided for by the sick fund), and has accumulated at least 200 weeks' contributions, he had a title to an incapacity pension, as long as he remains incapable; even if, for the rest of his life, he will never enjoy an old-age pension."

THE EIGHT-HOUR DAY IN FRENCH GOVERNMENT WORKS.

THE EFFECT ON OUTPUT AND COST OF PRODUCTION OF THE INTRODUCTION OF THE EIGHT-HOUR DAY.

Engineering.

ATTEMPTS to shorten the hours of labor in all trades by legislative enactment form one of the principal features of socialistic and labor movements in all manufacturing countries. The chief argument of the advocates of such measures is that the short working day benefits workmen and employers alike: the laborers have increased opportunities for rest and recreation and the employers profit by the increased energy and zeal of their workmen. It is safe to say, however, that the establishment of eight hours as the legal working day has never failed to work incalculable injury to the industries affected. The experience of the French government works as described in a recent number of *Engineering*, is one of the strongest evidences of the pernicious effects of such legislative interference.

"The consequences of the measure in those French Government factories in which it has been applied are absolutely deplorable. Certain departments had foreseen this, and the directors had asked for higher grants, in order to meet the higher expenditure which the reduction in the working hours was likely to entail. The fact is further confirmed by the Labour Bureau—an annex of the Labour Ministry, whose tendencies are distinctly favourable to all Socialistic measures. This bureau has recently published a series of reports on the eight-hour and nine-hour days in State works and arsenals, reproducing those issued by the chiefs of the said establishments; the reports in question give expression to the bare fact that decrease in the number of working hours has led to a decrease in output, and an increase in outlay.

"The eight-hour day was introduced in the French naval arsenals in 1902, by a former Minister of Marine, who is held largely responsible for the present unsatisfactory state of the French Navy. Without awaiting the results of the measure, he extended it to all the arsenals from the commencement of 1903. He certified that the first results were most satisfactory. In 1899 the eight-hour day was tried at the postage-stamp works; at first, as might be expected, the men increased in zeal in order that the measure should not be repealed, and, so far as the actual cost of working can be arrived at in a Government factory, where there is no commercial organization, it was found that during the first three months conditions under the eight-hour *régime* were approximately equal to those under the former ten-hour *régime*. But the effort on the part of the men was not maintained; an official report states the fact that the output decreased. Moreover, the authorities had done away with piece-work to please the men, and very soon after an increase in wages had to be paid to obtain the same output as formerly. But this did not prevent the authorities from extending the 'reform,' which now applies to all the postal and telegraph craftsmen throughout the country. Another official report establishes the fact that for an equal amount paid in wages (the men have as much for eight hours as they had for ten) the output has decreased by one-tenth, and in some cases by two-tenths; and this, notwith-

standing higher speed machines and a number of mechanical improvements. The men lay claim to producing 'better work,' because they have not to hurry as they did when on piece-work; but all persons who are able to visit the State factories know what to believe of this assertion. The authorities who have signed the official reports have concluded them by stating that 'it was hardly possible to expect better results.' And it is to such 'satisfactory' results that the Socialists appeal with a view to generalize the measure.

"In the National Printing Works the consequences have been similar. It was decided in 1905 to reduce the hours from 10 to 9 in the match and tobacco factories, the latter figure corresponding to eight effective working hours, and immediately afterwards it was necessary to open a supplementary credit of 2 million francs (80,000*l*) to meet the effects of the reduction. It has been officially recognised that the decrease in output would be exactly in proportion to the decrease in the working hours, and a proof of this is the circumstance that to enable the men employed on piece-work to earn as much as formerly, and without more labor, the basis price of their remuneration has been increased. The measure has led the State to incur heavy outlay in other directions; it has been necessary, among other things, to increase the shops and factories for taking on new hands in order that the available output should keep up with the demand. In the Mint the working day has been reduced also; the men would not consent to earn less—on the contrary, the wage per hour has been increased by 10 per cent. The men promised to produce as much in nine hours as in ten; this was the case for three months only, as in the above example, and the number of hands had to be increased afterwards.

"The most insignificant work in the naval arsenals costs fabulous prices. At the commencement of the 'reform' in these establishments the men showed zeal, but they soon slacked off, and found encouragement from the former Minister of Marine, who was then disorganizing the French Navy by conferring fresh favours; it is not astonishing, therefore, to find it reported that at Lorient Arsenal the cost of the output has increased by 15 per cent., following the decrease in the working hours. The Director of Cherbourg has stated that work did not exceed 7 hours 40 minutes; it had been reduced by 13 to 14 per cent., the reduction in output being no doubt proportional for the greater part of the *personnel*. He added also:

"'If it was hoped that the men, being less burdened with work, would compensate for the reduction in the working hours by good-will and eagerness for work, there has certainly been a mistake.' The eight-hour day became rapidly an accomplished fact, it was taken as a right, and the zeal of the early days completely disappeared. The most one notices is that there is, perhaps, less slacking off on the part of the men towards the end of the working day in the summer months. At Rochefort attempts have been made to tabulate the consequences of the 'reform' in the construction of torpedo-boats, and it has been found that the time for building these vessels has increased by 1.4 per cent. at least, and the cost by 7.5 per cent. The Ports authority who gave these figures has added in his report—and in this he is in contradiction with his colleagues in the other ports—that he has found an increase of activity on the part of the men, which he puts down at 14 per cent. One may ask in what manner he can reconcile this statement with the fact that work takes now more time, and is much more costly? Mr. Laubeuf, a well-known French naval architect, but who is not *persona grata* with the Naval Bureau, has stated, on the other hand, that the loss of output due to the measure is 19 per cent., and that the effective working-day now only amounts to 7 hours 10 minutes. He also had noticed at first an appearance of zeal on the part of the men, from which one might have hoped that, loyally worked to, the new measure would have given good results; but he was promptly disillusioned. At Toulon, in repair and maintenance work, the new *régime* entails a 24 per cent. increase in direct, and 33 per cent. in total expenditure. Here, as in the other arsenals, piece-work was done away with. The increase in expenditure of one-third at Toulon alone influences a total of 6 million francs (240,000*l*.) paid in wages.

"With regard to the establishments which are within the jurisdiction of the War Ministry, the nine-hour day was tried in a few instances and was then applied generally. The eight-hour day has been tried in one of these, an engineering works employing about 1,500 men, but the experiment was abandoned, and this would lead to the belief that the results were not favorable, notwithstanding the eagerness of the men who wanted the measure to become permanent. The fact is that in the works in question the eight-hour day led to a considerable increase in outlay. The conclusion arrived at in this case was that reductions in the number of working hours could, at best, only take place gradually, following improvements in machinery and in processes of manufacture; and this is exactly what will take place in private works when they are left alone to carry out their transformations, and are not pestered by ignorant legislators, whose chief object in life is, after all, the security of their seats. Such a movement has, in fact, taken place gradually from the commencement of last century.

"State establishments in every country are as badly placed as can be for carrying out experiments in this matter; none of their work is carried out on sound commercial or industrial lines. The experiments made in the French State establishments, and briefly outlined above, have, at all events, proved one point—that a reduction in the hours of labor corresponds immediately to a reduction in output and to a large increase in cost."

THE ECONOMICAL UTILIZATION OF LABOR.

A DISCUSSION OF THE BEST MEANS OF ATTAINING EFFICIENCY AND ECONOMY OF LABOR IN INDUSTRIAL OPERATIONS.

Henry L. Gantt—Stevens Indicator.

OF all the problems connected with industrial operation, none is of higher importance than the development of such a scheme of management as will obtain the most efficient and economical utilization of labor, but it is only within recent years that the subject has been given the attention it deserves. It requires but little study of the question to demonstrate the enormous gain in the efficiency of workmen when provided with proper tools and under proper direction, but the best results can be obtained only by exhaustive and careful research. The monumental researches of Fred W. Taylor on machine-shop practice are a conclusive proof of the value of scientific investigation. In an address delivered at the Stevens Institute of Technology, published in a recent number of the *Stevens Indicator*, Mr. Henry L. Gantt, who was associated with Mr. Taylor for a great many years, outlines the principles on which such investigations must be undertaken and the results which may be expected from the application of the "Taylor method" to industrial operation.

"Wherever any attempt is made to do work economically the compensation of the workman is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man and by fixing his compensation accordingly. This method, however, falls very far short of the highest efficiency, for very few workmen know the best way of doing a piece of work, and almost none have the ability to investigate different methods and select the best. It often happens then that a man working as hard as he can falls very far short of what can be done, on account of employing inferior methods, inferior tools, or both.

"In order to get the best results the following conditions are necessary: (1) Complete and exact knowledge of the best way of doing the work, proper appliances, and materials; (2) an instructor competent and willing to teach the workman how to make use of this information; (3) wages for efficient work high enough to make a competent man feel that they are worth striving for; (4) a distinct loss in wages in case a certain degree of efficiency is not maintained.

"These conditions are really the steps

that must be taken to get any piece of work done efficiently: (1) Learn how to do it right, and how long it should take; (2) teach a workman to do it in the manner and time set; (3) award the workman greater compensation for doing it in the manner and time set than he can ordinarily earn in any other manner; (4) make the conditions of pay such that if he fails to do the work either in the manner or time set he gets only his day's pay.

"Let us study these steps one at a time. The first is a scientific investigation of how to do the work and how long it should take. The fact that any operation, no matter how complicated, can be resolved into a series of simple operations, is the key to the solution of many problems. Study leads to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The logical method, therefore, of studying a complicated operation is to study the simple operations of which it is composed, a thorough knowledge of which will always throw a great deal of light on the complex operation. Also, the time needed for performing any complex operation depends upon the time of performing the simple operations of which it is composed. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: an analysis of the operation into its elements; a study of these elements separately; a synthesis or putting together the results of our study.

"It is well known that nearly every operation can be, and in actual work is, performed in a number of different ways; and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the best method. It is only by a scientific investigation that we can hope even to approximate the best solution of any problem.

"To analyze every job and make out instructions as to how to perform each of the elementary operations requires a great deal of knowledge, much of which is difficult to acquire; but the results obtained by this method of working are so great that the expenditure to acquire the knowledge is comparatively insignificant.

"Experience has shown that whether the labor is that of a Pennsylvania Dutch workman in a machine shop, a Hungarian laborer handling stock in the yard of a steel works, or a skilled cloth handler in a bleachery, the amount of work the average workman does under the ordinary conditions is only about one-third of what can be done by a proper workman under the best conditions. I could give other illustrations of this ratio, which seems to be fairly uniform. When a man sets his own task, as he virtually does in ordinary day work, he usually does about one-third of what a good man fitted for the work can do under the best conditions.

"As a result of our first step or our scientific investigation, in general, we find that it is possible, to do about three times as much as is being done; the next problem is how to get it done. No matter how thoroughly convinced we may be of the proper method of doing a piece of work and of the time it should take, we cannot compel a man to do it unless he is convinced that in the long run it will be to his advantage. We must go about the work in such a manner that the workman will have confidence in us and feel that the compensation offered will be permanent.

"When this condition of affairs is established we are ready to start a workman on the task, which, when properly set after an investigation, is such as can be done only by a skilled workman working at his best normal speed.

"The average workman will seldom be able at first to do more than two-thirds of the task, and as a rule not more than one out of five will be able to perform the task at first. By constant effort, however, the best workman soon becomes efficient, and even the slower ones often learn to perform tasks which for months seemed entirely beyond them. I dwell upon this subject, for the task must be such as can only be performed by industrious, skilled workers.

"If we have at hand such people that

already have confidence in us and are willing to do as we ask, the problem of getting our task work started is easy. This, however, is frequently not the case, and a long course of training is necessary before we can teach even one workman to perform his task regularly, for workmen are very reluctant to go through a course of training to get a reward, especially when they are being told on all sides, as is usually the case, that the high price offered will be cut as soon as they can earn it easily.

"Buying labor is one of the most important operations in modern manufacturing, yet it is one that is given the least amount of study. Most shops have expert financiers, expert designers, expert salesmen and expert purchasing agents—for everything except labor. The buying of labor is usually left to people whose special work is something else, with the result that it is usually done in a manner that is very unsatisfactory to buyer and seller. It is admitted to be the hardest problem we have to face in manufacturing to-day, and yet it is only considered when the manager 'has time' or has 'to take time,' or on account of 'labor trouble.' The time to study this subject is not when labor trouble is brewing, but when things are running smoothly and employer and employee have confidence in each other.

"Men as a whole (not mechanics only) prefer to sell their time rather than their labor, and to perform in that time the amount of labor they consider proper for the pay received. In other words, they prefer to work by the day and be themselves the judges of the amount of work they shall do in that day, thus fixing absolutely the price of labor without regard to the wishes of the employer who pays the bill.

"While men prefer as a rule to sell their time and themselves determine the amount of work they will do in that time, a very large number of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done and paid substantial amounts of money for doing it. The additional amount needed to make men do as much work as they can depends upon how hard or disagreeable the work is and varies from 20 to 100 per cent. of their day rate.

"If the work is light and the workman is not physically tired at the end of the day he will follow instructions and do all the work called for if he can earn from 20 to 30 per cent. in addition to his usual day's wages. If the work is severe and he is physically tired at the end of the day he requires from 40 to 60 per cent. additional to make him do his work. If in addition to being physically tired he has been obliged to work under disagreeable conditions or in intense heat, he may require 70 per cent. or even 100 per cent. additional.

"These facts are derived from experience and give us a key to the intelligent purchase of labor. For instance, if we wish to buy the amount of labor needed to accomplish a certain task, we must find out exactly and in detail the best method of doing the work, and then how many hours' labor of a man suited to the task working at his best normal rate and by the methods prescribed are needed to perform it.

"Most men will not sacrifice their present wages to earn a higher reward in the future, and even if they were willing few men could afford to. Therefore, while they are learning to perform the task, they must then be able to earn their usual daily wages, and the reward for the accomplishment of the task must come in the form of a bonus above their daily wage.

"As before noted a proper task is always greater than the ordinary workman can perform at first, and must be such as only the most skilled can perform. On the other hand, when the more skilled have been earning their bonus for some time, and the less skilled begin to realize that the prize is real and worth striving for, they make every effort to attain it and rapidly improve in skill.

"This increase in efficiency makes the payment of high wages possible, and it may be added that without efficient labor, permanent high wages cannot be paid indefinitely, for every wasteful operation, every mistake, every useless move has to be paid for by somebody and in the long run the workman has to bear his share.

"Good management, in which the number of mistakes is reduced to a minimum,

and useless, or wasteful operations eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. In other words, that management is best which utilizes labor in the most efficient manner.

"The best mechanical equipment of a plant that money can buy avails but little if labor is not properly utilized. On the other hand, the efficient utilization of labor will often overcome the handicap of a very poor mechanical equipment, and an engineer can have no greater asset than the ability to handle labor efficiently."

THE ARTIFICIAL DISPERSION OF FOG.

A DISCUSSION OF THE NATURE AND CAUSES OF FOG AND OF MEANS OF DISPELLING IT ON SEA AND LAND.

M. M. Dibos—Société des Ingénieurs Civils de France.

THE prevalence of fog on the west coast of Europe, creating a constant danger to the shipping of the British Isles and of France, has for many years turned the attention of physicists to the problem of its artificial dispersion. Some of the most important researches carried out within recent years have been those of a French engineer, M. Dibos, and a recent paper before the Société des Ingénieurs Civils de France outlines the results he has obtained.

When the temperature of the atmosphere falls below the saturation point, its content of water vapor condenses in the form of fine drops of water which remain in suspension in the air on account of their extreme smallness and the resistance of the air to their fall. The researches of Aitken have shown that for the formation of fogs the suspension of the minute particles of water must be made more or less permanent by association with extremely fine grains of dust. The microscopic particles of solid matter found in the atmosphere come from a great variety of sources. Inorganic matter is found in great abundance, caused sometimes by volcanic eruptions, but more usually a product of combustion or of the disintegration of the earth's crust; but in addition is found a multitude of organic substances of which the origin and nature are sometimes indeterminate. Atmospheric dust is, of course, found in greatest quantities on land, especially near large centres of population where smoke plays an important part in its production; but considerable quantities have been found at sea at great distances from land, whence they had been carried by high winds and by normal currents of air. Wherever they occur these particles have the property, under suitable conditions of temperature and pressure, of condensing on themselves the water vapor in the air. The small globules of water thus formed, each containing a particle of dust, remain suspended in the air in a state of unstable equilibrium and their accumulation produces fogs of greater or less density.

In 1899 M. Dibos happened to be on board a Channel steamer which ran into a dense bank of fog. He noticed that in the immediate vicinity of the mouth of one of the stoke-hole ventilators there was a clear space of considerable size. He immediately conceived the idea that the mechanical shock of the heated air destroyed the equilibrium of the particles of water and caused them to fall. A few experiments with a small fan confirmed this opinion. Convinced, therefore, that a much larger space might be cleared by the projection of heated air under considerable pressure, M. Dibos continued his researches and devised a simple apparatus which under test produced in a dense fog a clear space over 200 yards long.

M. Dibos' first apparatus, which was especially adapted for use on steamships, consisted essentially of a cast-steel, steam-jacketed cylinder, communicating with the outer air by means of a pipe fitted with a valve and bent so that the axis of the

cone-shaped, copper mouthpiece was horizontal. In foggy weather compressed air was piped into this cylinder, heated by the steam circulating in the steam jacket and then discharged into the fog. The discharge pipe was pivoted so that the compressed air could be discharged in any direction.

Continuing his researches M. Dibos decided to experiment with electric waves which he thought could be so utilized as to give better results than he had obtained with heated air and in 1904 he installed an apparatus at Wimereux-Plage, near Calais. In this installation electrical energy at a potential of 140,000 volts from an electrostatic machine was discharged into the air from a series of copper points. These points were about 80 feet above the ground. Several tests made in an extremely dense fog showed that electric waves at this potential can produce a complete dispersion of fog within a radius of from 50 to 60 yards.

M. Dibos considers that his researches are as yet in a very incomplete state. He is convinced, however, that electro-static machines are not well adapted for the generation of high-voltage electricity for fog dispersion on account of the fact that such machines are much affected by dampness. Within the next few years, it is reasonable to suppose that further developments will produce apparatus which will be powerful enough to disperse fog for a radius of at least 400 yards. The importance of the problem can hardly be overestimated, particularly in connection with the shipping industry. Its application in connection with railway signal systems also is only a matter of time, the Northern Railway of France having already installed an experimental station at its Paris terminal.

SEISMIC DISTURBANCES AND COLLIERY EXPLOSIONS.

A DISCUSSION OF THE REMARKABLE ASSOCIATION OF COLLIERY EXPLOSIONS WITH PERIODS OF SEISMIC DISTURBANCE.

James T. Beard—Engineering and Mining Journal.

THE important subject of the causes of colliery explosions is interestingly treated by Mr. James T. Beard in a recent number of the *Engineering and Mining Journal.* After discussing the faults of management and the carelessness of inspectors and laborers to which coal-mine disasters are so often due, Mr. Beard turns to a consideration of the natural agencies which affect the explosive condition of mine air. While he grants that barometric pressure has a certain influence, he considers that by far the greatest factor in the formation and liberation of gas in collieries is seismic disturbance.

"I have yet to mention an agency that is probably responsible for explosive conditions in mines to a greater extent than any yet named. I referred a year ago, in an article on mine explosions, to the lack of attention given by mining men to the variation of pressure of gas that may occur within the strata, from whence mine gases emanate. I believe as the result of several years' close observation that internal pressure is the cause of larger, spasmodic emissions of gas. The ground for this belief, which is at least reasonable, is as follows: It is a matter of general observation that the flow of gas in all mines located in regions or districts where gas may be expected is spasmodic. Even in districts producing large quantities of gas and which therefore appear to furnish a constant emission, there is a very perceptible ebb and flow, causing periods or fluctuations in the gaseous condition of the mines. In other districts and mines there are corresponding periods in which much gas is given off, followed by intervals where there is almost an entire absence of gas in quantities to cause alarm. Often these periods of the ebb and flow of gas from the strata are quite local, that is, restricted to a limited area or district, and at times appearing in a single mine or portion of a mine only. Several instances have recently occurred where the flow of gas increased in a portion of the mine so rapidly that the men were withdrawn from that district and not permitted to return for nearly a month when the flow ceased almost entirely.

"Observations such as the foregoing

prove quite conclusively the existence of conditions or agencies that affect the emission of gas locally and from within. No atmospheric changes could produce local phenomena such as these. We possess very little exact knowledge of the condition of the interior of the earth, but the evidence of volcanoes in action and our knowledge of the agency of heat and pressure make it certain that tremendous activities are in constant operation within the earth's sphere. It is both natural and reasonable to suppose that the pressures in subterranean channels that will discharge molten material under the great head due to the height of a volcano, can make themselves felt in other quarters, and incidentally augment the outflow of gas from strata already pregnant. No one familiar with underground conditions and who has listened with awe to the mysterious "poundings" in the overburden of a mine, caused, as is well known, by the working of gas in the foliations of the strata, can study the phenomena of earthquake waves and shocks without being convinced of the close relationship of the different phenomena. The conclusion is fairly certain that gas generated by the chemical and physical activities within the earth plays an important part in all these phenomena.

"I have previously drawn attention to the close association of volcanic activity and mine explosions, and will only briefly refer to these here. The theory of spasmodic or irregular earth breathings, as just explained, if true, would give rise to periods of frequency of mine explosions, more or less closely associated with volcanic activity. That such is the actual fact is shown to be highly probable by the remarkable coincidence in their occurrence. That there are isolated or errant mine explosions occurring in a period of rest and entirely dissociated from seismic disturbance, does not argue against the theory, since it is not claimed that all mine explosions are the result of such disturbance. The causes producing explosive conditions in mines are too numerous to invite such an expectation. But when periods of marked seismic troubles are almost invariably accompanied by the appearance of gas in increased quantities in mine workings, and the occurrence of one or more mine explosions, the fact is significant of something more than mere chance.

"The terrible eruption of Mt. Pelée that devastated the island of Martinique, West Indies, May 20, 1902, was accompanied by four prominent mine explosions in a period of less than three months, causing the loss of 550 lives. Two of these explosions occurred at practically the same time as the principal eruption of the volcano. The record is as follows: May 19, 1902, Frayterville, Tenn., explosion, 184 lives; May 20, 1902, Mt. Pelée, eruption, 28,000; May 23, 1902, Fernie, B. C., explosion, 127; July 10, 1902, Johnstown, Penn., explosion, 112; August 1, 1902, Wallangong, N. S. W., explosion, 127.

"This was followed by two or three years of comparative rest, only to be succeeded by a still more terrible and prolonged season of disquiet. From early in the year 1905 to the present time there has been an unbroken succession of seismic disturbances marked by some of the most terrible mine disasters ever recorded. The record of the principal occurrences is as follows: January 4 to 24, 1906, three mine explosions, United States, 54 lives; February 8, 1906, Parral, W. Va., explosion, 27; February 19, 1906, Maitland, Colo., explosion, 16; February 21, 1906, Colombia, S. A., earthquake, 2,000; February 27, 1906, Piper, Ala., explosion, 9; March 10, 1906, Pas-de-Calais, France, Courrières explosion, 1,200; March 17, 1906, Formosa, Japan, earthquake, 3,000; March 22, 1906, Century, W. Va., explosion, 21; March 28, 1906, Takashima, Japan, explosion, 307; April 3 to 17, 1906, Vesuvius, Sicily, 500; April 7, 1906, Formosa, Japan, earthquake, 109; April 18, 1906, San Francisco, Cal., earthquake, 2,000; April 20, 1906, Calumet, Mich., fatal; April 20, 1906, Honolulu, fatal; April 21, 1906, Trinidad, Colo., 23."

Mr. Beard enumerates many other minor disasters and concludes:

"These terrible records tell significantly of the danger that exists in mine workings during periods of seismic unrest. Undoubtedly much trouble has been avoided by the increased vigilance and care exercised of late in mines by reason of the attention that has been drawn to the subject, and it is to be hoped mine officials will not relax precautions."

DEPRECIATION OF ELECTRICAL PLANTS.

A DISCUSSION OF THE NECESSITY OF PROVIDING DEPRECIATION AND ANTIQUATION FUNDS IN ELECTRICAL OPERATIONS.

Robert Hammond—Institution of Electrical Engineers.

THE determination of the method and amount of the provision which should be made for depreciation of plant and machinery is one of the most perplexing problems in the economics of industrial operation. The necessity of making allowance for depreciation in the annual balance-sheet is universally recognized, but the methods of making such allowance are many and based on widely differing principles. This is particularly the case in electrical-supply undertakings in which development has been so rapid as to prevent the formulation of any standard rules on the subject. A recent paper by Mr. Robert Hammond, read before the Institution of Electrical Engineers, gives an interesting discussion of the various theories in regard to the provision for depreciation in electrical plants.

"In arriving at the net profits earned during any given period by an industrial undertaking, it is obvious that a determination should be made of the extent to which the assets of the undertaking have depreciated in value during that period. Where machinery and apparatus are employed it is necessary to estimate their probable 'life,' which, in the case of undertakings working on well-established lines, may be easily arrived at. Having fixed a definite figure for the life, the sum which is equivalent to the annual depreciation of the machinery and apparatus may be written off annually and debited to the gross profits, this book entry involving no withdrawal of money from the undertaking; or out of the gross profits annual investments may be made of such sums as will, at compound interest, reach the amount of the original cost of the machinery and apparatus by the time that they are worn out.

"Turning to electricity supply undertakings, one finds that their development has been so rapid, and the working conditions have so greatly altered in so short a time, that no standard method has yet been agreed upon for dealing with the question of depreciation, and no definite course has been pursued. The word 'depreciation' is used in a wide sense, and it is desired to include in this inquiry not only the consideration of the provision which should be made to cover the depreciation in value of the assets of an undertaking, but also as to what other charges beyond the ordinary working costs should be debited to the revenue account before arriving at the net profits of the undertaking. Following these lines, we have first to consider the question of depreciation proper, then the advisability of creating a reserve fund to provide for unforeseen expenses which may be incurred owing to accident or other emergency, and, lastly, the provision of a further fund to cover antiquation of machinery, apparatus, and mains, thereby preparing for the possible necessity of scrapping machinery, etc., which may be in good working order, but which may have become obsolete owing to improvements introduced in methods of generation and distribution. . . . . .

"The conditions governing the working of electrical supply undertakings are such that, in order to give a continuous supply of electricity, it is essential that machinery, apparatus, and mains should be kept in a high state of efficiency. The cost of so maintaining the plant is, of course, regarded as part of the working costs, and is assumed to be so dealt with. Plant, well maintained as it may be, must, however, gradually depreciate, and a time will come when the frequency and extent of repairs and renewals necessitate so heavy an item of annual expenditure that it is preferable to replace it with entirely new plant. In order to arrive at the amount with which the gross profits should be debited annually in order to cover this depreciation, it is necessary to settle the number of years which will elapse before the various classes of plant and apparatus in use will arrive at the scrapping stage and will require entire renewal. At the outset we are confronted with the difficulty that the life of machinery so largely depends upon the way

in which it is maintained, that a definite period at which any particular class of machinery or apparatus would in the ordinary course be entirely worn out can hardly be taken as of universal application. On the basis, however, that all plant would be carefully maintained and faulty parts renewed out of revenue, it is suggested that the periods named below represent a fair approximation of the life of the various classes of machinery and apparatus, etc., named:

Estimated Years of Life.

Land and buildings	60
Machinery and plant—Boilers	20
Pumps and pipework	25
Conveyors	10
Engines	25
Turbines	20
Dynamos and alternators	25
Motors	20
Tools and sundries	10
Accumulators	15
Transformers, static	15
Converters, rotary	20
Switching apparatus and instruments	20
Meters	10
Mains—Armoured	25
Solid system	30
Ducts	30

"If the above periods be accepted, it becomes a simple calculation as to the amount which must annually be written off or set aside to a sinking fund.

"Reference has already been made to the alternative methods of dealing with the depreciation fund. Of those methods doubtless the sounder is that which provides for the annual investment, outside the undertaking, of such sums as will, accumulated at compound interest, represent from time to time the actual ageing of the machinery, apparatus, mains, etc. It is true that if this method were adopted, each extension of the undertaking would necessitate the raising of fresh capital which would have to be subscribed either by the existing shareholders or by the general public. Although this might cause inconvenience, yet, nevertheless, it is urged that by this method a far more definite control would be established over the growth of the undertaking, and the shareholders would have the option of either investing or refraining from investing further capital in it instead of being compelled to do so through the investment of the depreciation fund monies in it.

"It is also urged that should the course advocated be pursued the company with such an asset at its back would be in a far more favourable position as regards the issue of fresh share capital than it would be if it had invested its depreciation fund in extensions and was compelled to go to the public for more capital, at a time when a large proportion of its machinery and plant had become worn out.

"In support of this contention it is pointed out that in many undertakings, not only is the existing plant written down in value in the balance sheet, but since the balance so obtained does not exist in cash, it has been considered necessary to form a separate fund, called a renewals fund, which is retained as cash for the purpose of renewing such items as have an exceedingly short life, such as the track in a tramway undertaking.

"It seems to be unreasonable that profits should be debited not only with depreciation, but also with contributions to a renewals fund. If the depreciation fund existed in readily convertible securities instead of being invested in the undertaking for extensions and the like, it would be available, in the case of a tramway company, to renew the track as soon as the rails were worn out, and the monies otherwise placed to the renewal fund would have been distributed as profits.

"One, of course, gets back to the fact that for the purpose of extensions, fresh issues of capital would be required from time to time, and most directors would doubtless think it preferable to use the money which they had actually in hand before they made an appeal to their shareholders or to the outside public for further share capital. This, indeed, is the method that has almost universally been adopted by the electricity supply companies operating in London.

"As regards the second item, to which reference has already been made as coming within the purview of the paper, namely, the provision of a general reserve fund, it seems to the author that, however wise the formation of a general reserve fund might be for the purpose of equalisation

of dividends, it nevertheless does not rank as a strict necessity as does a depreciation fund. Further, he does not agree with those who hold that such a fund is necessary, not only for the equalisation of dividends, but for the purpose of providing against extraordinary expenditure due to unforeseen emergencies. Such emergencies are causes by accident in one form or another, and such risks should be fully insured against and the premiums regarded as part of the ordinary working costs.

"Lastly, there is to be considered whether a fund to cover antiquation should be deemed obligatory. It has been urged on the one hand that no provision whatever need be made under this heading. Those who hold this view contend that any great revolution in engineering methods which would cause their present plant to become obsolete would necessarily carry with it its own advantages, either in the direction of a great improvement in efficiency or in an extension of the uses to which electricity might be put. They contend that these advantages if really extensive would in themselves more than pay for their adoption, and that unless a company could see its way to larger dividends by adopting an improvement, it would, of course, continue on the old lines.

"On the other hand, many hold the view that an antiquation fund is of vital importance, and they point out that a radical improvement might arise which entirely superseded the existing methods of generation and distribution, and while such an improvement would entirely take the field in opposition to the present methods, nevertheless the improvement might not carry with itself a sufficient margin of profit to cope with the dead weight of interest on capital expended upon superseded plant. A company without an antiquation fund would then be faced by the possible competition of a new concern not so over-burdened with capital charges which would completely relieve them of their business.

"The author does not share the latter view to the full extent, but, on the other hand, he thinks that no electricity supply undertaking can be regarded as in a thoroughly sound position unless some provision has been made in the direction of an antiquation fund. At the same time this provision is, in his opinion, not one which would rank on the same footing as a depreciation fund *per se*, but is one which might wisely be contributed to out of profits as a sort of nest-egg for the future.

"To arrive at an absolutely accurate amount of annual contribution to a depreciation fund it would be necessary to determine the residual value of the machinery, apparatus, etc., at the end of their respective lives. In the case of land it, of course, remains, and the scrap value of machinery, apparatus, mains, etc., containing a fair amount of copper and other metals, is appreciable. As, however, a depreciation fund must in its nature be based upon an estimate, it has seemed to the author wise to regard the residual value as an item which the undertaking would have to the good at the end of the respective lives, and one which to that extent would be in hand as a contribution towards the cost of new plant."

THE BRENNAN MONO-RAILWAY.

AN APPLICATION OF THE PRINCIPLE OF THE GYROSCOPE TO TRANSPORTATION PROBLEMS.

The Electrician.

MR. LOUIS BRENNAN, the inventor of the Brennan torpedo, recently turned his attention to the application of the gyroscope to transportation problems and has produced a monorail car which is considered, in some quarters, to be destined to revolutionize railway operation. A small model of the car, shown recently at a meeting of the Royal Society, amply demonstrated the practicability of the system, showing remarkable stability under most difficult conditions. A recent number of *The Electrician* gives some details of the system and outlines the advantages claimed for it.

"The characteristic feature of this system of transport is that each vehicle is capable of maintaining its balance upon an ordinary rail laid upon sleepers on the ground, whether it is standing still or mov-

ing in either direction at any speed, notwithstanding that the centre of gravity is several feet above the rail, and that wind-pressure, shifting of load, centrifugal action or any combination of these forces may tend to upset it.

"Automatic stability mechanism of extreme simplicity, carried by the vehicle itself, endows it with this power. The mechanism consists essentially of two flywheels rotated directly by electric motors in opposite directions at very high speed, and mounted so that their gyrostatic action and stored up energy can be utilized. These flywheels are mounted on special bearings, and are placed in cases from which the air has been exhausted, so that both air and journal friction is reduced to a minimum, and consequently the power required to keep them in rapid motion is very small. It is stated that the stored up energy in the flywheels of the larger vehicles when revolving at full speed will be so great and the friction so small that if the driving current is cut off altogether they will run at sufficient velocity to impart stability to the vehicle for several hours, while it will take from two to three days before they come to rest.

"The stability mechanism occupies but little space and is conveniently placed in the cab at one end of the vehicle. Its weight is also small, about 5 per cent. of the total load being considered an ample allowance for the first vehicle.

"The road wheels are placed in a single row beneath the centre of the vehicles, instead of in two rows near the sides as usual, and are carried on bogies or compound bogies, which are not only pivoted to provide for horizontal curves on the track, but for vertical ones also. By this means the vehicles can run upon curves of even less radius than the length of the vehicle itself, or on crooked rails or rails laid over uneven ground without danger of derailment.

"The motive power may be either steam, petrol, oil, gas or electricity, as considered most suitable for local conditions. In the full-sized vehicle now being built, however, it has been decided to use a petrol-electric generating set, for the supply of current to the road wheel motors and to the stability mechanism. Such a vehicle will have the great advantage of being always ready for immediate use, the gyroscope wheels being kept constantly running by current from a small battery of accumulators while the engine is at rest.

"In order that the vehicle may be able to ascend steep inclines the wheels will be power driven, and change gears provided for use in hilly country. It is also possible to run free wheel down hill at a high velocity, so that a good average speed can be maintained.

"The system points to great economy resulting from making the vehicles wider in proportion to their length than on ordinary railways, and it has, therefore, been decided to make the experimental waggon 12 ft. wide, or one and a half times as wide as usual. For civil work in the colonies the vehicles will probably be two or three times as wide, if not more.

"Brakes capable of being operated by pneumatic or manual power will be provided for all the wheels.

"The rail, which is of ordinary section, only requires to be the same weight as one of the rails on an ordinary line in order to carry the same load on the same number of wheels in each case. The sleepers also only require to be one-half the length to give the same area of support to the vehicle.

"Flying lines of railway can be laid with great rapidity over uneven ground with slight expenditure of labor, specially-designed building-vehicles, also on the monorail principle, equipped with electric gear for handling the rails, being kept at the rail head for the purpose. It is confidently anticipated that, working in this manner, it will be possible to keep up with an army on the march, and supply them with all their requirements.

"For temporary work, bridges may be of the simplest possible construction, a single wire hawser stretched across a ravine or river being all that is necessary. These hawsers can be built up on the spot from separate wire rope strands, so that the transportation of them becomes an easy matter. It is stated that lateral swaying of the hawser will not disturb the balance of the vehicles, and that the strongest winds will not blow them off. In other cases of bridge building, a single row of

piles with a rail on top will suffice, or a single girder carrying the rail may be conveniently used.

"The expenditure of fuel is expected to be smaller than on ordinary lines, owing to the absence of flange friction on curves, and to the vehicles running without oscillation or jolting.

"The speed may be from twice to thrice that of ordinary railways owing to the smoothness of running of the vehicles, and to the total absence of lateral oscillation.

"Vehicles provided with their own motive power can go wherever a single rail is laid, and, besides carrying a substantial load themselves, are also capable, on tolerably level country, of supplying current to other vehicles unprovided with power-generating plant.

"The advantages claimed by the inventor for his system are:

1. Almost incredible speeds are expected to be attained on high-class lines laid on this system, owing to the total absence of lateral oscillation caused on ordinary lines by the impossibility of laying two lines exactly level and parallel with each other. From twice to thrice ordinary railway speeds are to be expected.

2. The fact that the vehicles lean inwards to the correct angle when taking curves secures them from derailment at the highest speeds. The curves would, of course, have to be suitably approached to give the vehicle the time necessary to assume the proper inclination at the particular speed adopted and the line would have to be laid accordingly.

3. It is certain that for "high-class" transcontinental lines, the vehicles will be very large, so large indeed that they will more resemble ships on shore, or traveling hotels, than vehicles as we know them now.

4. Perfect comfort in traveling owing to there being no oscillation.

5. Saving of material required for construction of line in the way of rails, bridges, sleepers, etc.

6. Small first cost and small cost of maintenance.

7. Traveling will be much safer owing to the absence of danger of derailment at high speeds."

THE PROFESSIONAL IDEALS OF THE TWENTIETH CENTURY.

A PLEA FOR THE HIGHER CONCEPTION OF THE ENGINEER'S RELATION TO SOCIETY.

Arthur Twining Hadley—Dedication of the United Engineering Societies' Building.

THE progress of civilization in the nineteenth century is generally conceded to have been due largely to the development of applied science. Engineering, therefore, which a hundred years ago was but a subordinate branch of the military art, has become a dominant factor in the material development of nations and to-day the engineering profession is recognized as the most important part of industrial and commercial organization. The commercialism of the age is, however, likely to prevent the development of the engineer as a factor in the social and political life of his country. At the recent dedicatory exercises of the building of the United Engineering Societies, President Hadley of Yale University discussed the opportunities of the engineer for public service and made a plea for a higher conception of professional ethics.

"The great element of progress in the nineteenth century has been the recognition on the part of mankind in general, of the value of scientific generalizations in every department of human conduct. Our science has become sounder, our understanding of its applications clearer, and the public has recognized that scientific conduct of a business means the substitution of universal experience, learned with difficulty and applied with toil, for the narrower range of individual experience which was at the disposal of the so-called practical men of fifty or a hundred years ago. Of this change the engineer is the representative and the leader. He it is that makes physical science in its various lines applicable to the complex problems of construction and development. He it is who has paved the way for the recognition of the technologist and the expert in every line of human industry. He it is who has shown how mathematics, instead of being

an abstract discipline, remote from every day human affairs may become the means of applying truths for a long time remote and undiscovered, to the every day affairs of the world in which we live. Not the buildings that you have built; not the railroads that you have planned; not the machines that you have invented, represent your greatest achievement. Yours is the proud boast of having in one brief century established science as the arbiter of the material affairs of mankind, and of having enforced her worship upon a world once reluctant, but now gloriously admiring.

"Well, then, you will ask: is there anything which remains to be done comparable in importance to this? Yes, there is. An equally large part—perhaps in one sense a much larger part—of your professional duty yet remains to be accomplished. It is not enough to have technical training. It is not enough to know the special sciences on which the practice of a profession is based. A man ought to have clear conceptions of the public service which his profession can render, and the public duty which its members owe. Thus, and thus only, can the engineer, the lawyer, the physician, or a member of any other learned profession, rise to the full dignity of his calling.

"For there are two quite distinct qualities which must be combined in order to secure the best professional services; two quite distinct tests which work must meet in order to be pronounced first class. One of these is the technical standard; the other, for want of better word, may be called the ethical standard. The man who wishes to build a good railroad must not only lay it out according to the rules of the surveyor's art, with proper curves and grades, and bridges which will not fall, but he must also have intelligent regard to the needs of the population, the safety of travel, and the many other factors which determine whether a railroad shall be a work of public use or a source of industrial bickering and financial disaster. This combination of public and private demands is not peculiar to engineering. It can be illustrated in every other profession of importance. It is not enough for the lawyer to give advice which shall be technically sound, and which shall enable his clients to keep out of jail. He must learn to take a large view of the law as a means of public service instead of private gain. It is not enough for the physician to know how to cure specific diseases. He must know how to care for the larger problems of public health, and to use the resources of the community in a way to meet as fully as possible its sanitary needs.

"This larger view of professional obligations is not so fully recognized as it should be. We have in the nineteenth century made so much progress in the technical training of doctors and lawyers and engineers that we sometimes forget that there is need of anything more than technical training. We have let the old idea of public leadership, which was prominent in the minds of the great professional men of past centuries, give place to another and narrower ideal which is fully satisfied when a man has made himself a technical expert. Many a man of real eminence in his calling deliberately rejects the wider conception of professional duty which I have here indicated. Perhaps he recognizes the claims of public service; perhaps he does not, but in any event he believes that these claims rest upon him as a man rather than as an engineer or a lawyer. In his professional capacity he says he is hired not to tell what the law ought to be, but what it is; not to advise how a railroad can do the most public service, but how certain men with certain ideas of their own can best use the differential calculus to get these ideas carried out. This is perhaps the prevalent view of professional ethics to-day. I believe that it is a wrong view, which must menace not only the influence and standing of the professions themselves, but the general interests of the republic.

"Mere technical achievement is not the thing that endures. Among the peoples of the ancient world, I suppose that there were no engineers equal to those of Egypt. Considering the means at their command, the things they did were absolutely extraordinary. They did some things which, even with the means at our command, we can hardly duplicate. But they used their abilities in the service of a dominant priestly caste; and therefore, while their work fills us with admiration, it does not

appeal to us as does the work of the Roman engineers a few centuries later, who built roads and aqueducts and bridges, and thus took the lead side by side with the Roman lawyers in establishing the basis of modern civilization. The roads and bridges of Rome, simple and straightforward as they are, constitute a more enduring monument to the Roman engineers than all the obelisks and pyramids that were ever erected.

"A commonwealth like that of the United States is necessarily governed by public opinion. Courts may formulate this opinion. Legislatures may pass rules to give effect to it. Police may enforce its demands against the recalcitrant. But the governing power rests in the intelligent public opinion itself. When that opinion ceases to be intelligent and powerful, freedom becomes a mere name. Now, a serviceable public opinion of this kind can only be formed when intelligent people, technically trained for different lines of life, seriously try to find out how their work can be made to meet the public needs. They are the only ones who can do this well. If it is done by anybody else it will be done badly. If the lawyers as a class try to keep the law in line with the demands of intelligent public opinion, we can get good law. But if the lawyers are content to see the law perverted to private ends, and judges take refuge in technical construction of precedents, without full regard to the needs of the existing situation, legislatures will step in to create a chaos of conflicting laws which are worse than no law at all. In like manner, if our engineers get their own minds clear, and get the public mind clear, as to the political economy of the properties entrusted to their charge and the ethics of their management, they can forestall these conflicts which now threaten to break out at every moment. But if the members of a profession whose advice is necessary for a clear understanding and wise settlement of these problems retire from the field of action, the matter will be settled by those whose interests are more selfish and less farsighted. There are three professions today which do not regard themselves as servants, but as masters—the financier, the journalist and the politician. If the engineer and the lawyer accept positions as servants, simply putting their technical knowledge at the disposal of merchant, journalist, or politician who will pay the highest price for it, it is not simply a confession of inferiority, it is a dereliction of public duty."

THE GAS-POWER SITUATION IN AMERICA.

A CRITICISM OF THE MANUFACTURING METHODS TO WHICH ARE DUE AMERICA'S SLOW PROGRESS IN THE APPLICATIONS OF GAS POWER.

F. E. Junge—Power.

ATTENTION has been drawn repeatedly in the columns of THE ENGINEERING MAGAZINE to the fact that the extreme systematization and specialization of American methods of manufacture are rapidly producing a stagnation which precludes the possibility of progress and improvement. In the June number Dr. Louis Bell pointed out the influence which the unwillingness of the American manufacturer to depart from standard types is having upon the trade of the country, drawing his illustrations from a great variety of industries. The status of gas power in the United States is one of the most striking examples of the paralyzing effects of excessive standardization on industrial progress. During the past two years Mr. F. E. Junge has contributed to *Power* a long series of articles on gas-engine practice in Europe and in a recent number of that magazine he gives his view of the reasons for the backward state of America in the development of the applications of gas power.

Mr. Junge first points out the enormous economic importance of the gas-power problem. In 1906 the aggregate power developed in the United States amounted to 14,465,000 horse power, of which 10,664,560 were developed from steam and only some 300,000 from gas. In the same year the coal consumption for power purposes was nearly 100,000,000 tons. "Figuring at an

average price of $2 per ton, it is obvious that the universal adoption of a method of generation which will render an equivalent power service with one-half the consumption will represent an annual saving of some $100,000,000, disregarding entirely what the saving in fuel means to future generations."

Speaking of the literature on gas-power problems available in the United States, Mr. Junge says that it seems to be devoted to one of three aims: "The abstract study of the internal thermo-dynamic relations of gas-producing and converting apparatus; the quantitative side of design of their mechanisms, and the historical or inventive evolution of the problem. All of these modes of treatment are interesting in themselves and valuable in their combination. Perceptibly the cultivation of the mechanical engineering part, that is, the theory of the construction of gas producers and engines, as an expedient in the practical development in the art is most vital to the question, greatly more so than is a purely hypothetical analysis of the physical and chemical phenomena occurring in the working cycle.

"There is, however, one more side to the subject, which so far has been entirely neglected and the want of which is acutely felt by the trade, namely, the broad economic aspect of the gas-power problem, its relation to the iron, coal and kindred industries, and its scientific and impartial presentation to men, professional and mercantile. There should be more treatises to appeal to the interests of wider industrial and commercial circles, demonstrating the possibilities and clarifying the limitations of the application of gas power in the varied industries.

"The scarcity of good literature available on gas-power engineering in this country is due, in the first place, to the unfortunate but incontrovertible fact that those men whose learning and experience would enable them adequately to discuss and propagate the subject in professional circles are not permitted by the firms controlling their services to make public such data as would be of direct practical usefulness to the working engineer. To the foreign observer of American industrial methods this policy of reserve unquestionably appears distinct from the broad-minded course of action which is pursued by the majority of other governmental or private institutions. In fact, it seems dictated by traditional rather than by logical motives, since there certainly would be less injury done to the commercial interests of manufacturers by a liberal exchange of useful information than by promoting—as they deem wise to—the publication of literature of the sort that is nowadays distributed by their publicity men. Whether or not this hermit-like attitude of isolation and secrecy, as Dr. Lucke terms it, be beneficial to the earning end of manufacture, there can be no doubt that it works direct harm to the propagation of technical truth among professional men. It is owing to this very secrecy that the technical student of this branch of engineering cannot, except for the merely fundamental principles involved, rely on what form otherwise and elsewhere the most valuable sources of information, namely, the current technical periodicals, and the professional papers read before the national engineering societies. For the majority of material and discussion advanced, so far as it is not of an entirely academic nature, relates to efficiencies and performances of commercial machinery, being obtained from the advertising or publicity staffs of the large manufacturing concerns, who, no doubt, withhold all information except that which presents the good features, and those only, of their products.

"I am bold enough to go so far as to say that the commercial success of any novel machine depends, in this country, more on the ability of the sales department than on the real technical merits of its design. For it is conceded that fuel cost, which is still considered by some as a secondary factor in power-plant economics, is hardly ever ascertained, after a period of probation in practice, by impartial investigators, since manufacturers and users alike are yet pleased to get continuous and reliable service at almost any price. Satisfaction such as this, though comfortable for the builder, is far from conducive to further progress in the mechanic arts. In fact, it is prejudicial to it.

"Another obstacle, and one equally traceable to other lines of manufacture, is that

after a few years of unchallenged growth too much capital has been invested in one special form or pattern, and not enough of skilled talent has been provided to allow of any radical changes to be instigated. Profit-making management, so long as it is concerned with present dealings only, must disapprove of the frequent alterations in design so essential in a developing field, because investors clamor for immediate returns, and for the greatest possible revenues from the capital invested.

"Progressive engineering in general, and our special branch in particular, would ultimately derive much greater benefit from careful experimental investigation and thorough scientific research, if the key-note of opportunism and immediacy were not so preponderatingly sounded: Immediate results, immediate satisfaction, immediate earnings! The full measure of prosperity in the fat years, and the ability to tide over the lean ones, are the results of forethought and preparation of a different character. The stability of modern industry requires that some money, some labor, and some time be expended for operations other than those which tend to produce the maximum income immediately.

"But here is where this special trouble is wedded to the lamentable plague of commercialized engineering which is threatening us to-day in all progressive countries: monopoly, the great discourager of effort in trade, manufacture and profession, will dictate the technical methods to be followed, thereby suppressing individual aspirations; few great corporations will buy up the highest grade of skilled talent, literary, inventive, mechanical, but will keep it latent or, at least, barren of creative work, by raising almost insuperable barriers to the propagation of the fruits of its labor.

"Gas-power engineering is no exception to the rule. It is in spite of the antagonistic attitudes exhibited by the large manufacturing corporations, and without their sanction that the writer has begun his campaign of publicity, moved by the earnest desire to reciprocate for the wealth of impressions received during his studies in this country, in setting before the ambitious and studious reader such achievements, and the ways for attaining them, as have been realized in this line abroad. Happily for the development of the art and for the purse of the power user, the destiny of this particular industry is not controlled yet, as is that of the electrical industry, by a few huge co-operating corporations, and an alternative to unsatisfactory dealing is still available. It is hoped that the vastness and multiplicity of interests involved in the gas-power field will effectively prevent centralization of the kind that precludes a stable and healthy industrial growth."

THE NEW HARBOR WORKS AT BRUGES.

A SUMMARY OF THE WORK BEGUN IN 1896 AND NOW NEARING COMPLETION.

Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.

THE city of Bruges, the chief town of West Flanders, was as early as the middle of the tenth century one of the largest North European markets. It continued to gain in wealth and importance for about five centuries, until 1435, when political complications and the silting up of the approaches to the harbor began to cause the gradual decline of the prosperity of the town. Schemes were put forward at various times to establish fresh means of communication with the Channel, the North Sea or the Scheldt, but were either ignored or left uncompleted. Between 1870 and 1880, however, a new scheme was drawn up for a ship canal to connect Bruges with the North Sea at Heyst. This scheme was not allowed to drop, and the Belgian Government in the early nineties invited tenders for the work. Instead of Heyst, however, a site situated about midway between Heyst and Blankenberge, and ultimately called Zeebrügge, was finally decided upon as the most suitable place for the outer harbor. Work was begun in 1896 and is now nearing completion. The following details of the harbor works are taken from a recent number of *Oesterreichische Wochenschrift für den Oeffentlichen Baudienst.*

The inland harbor at Bruges consists of three basins. The west is 550 metres long, 63 metres wide at the bottom, 90 at the water line, and 100.6 between tops of banks; the slopes of the banks are protected by loose stone embankments. The east basin, 320 by 90 metres, has brick quays with rubble stone facings. The north basin is 300 metres long and 200 wide and its banks are protected by stone flagging. A hydraulically-operated lock connects the west basin with the canal from Bruges to Ostende. This lock has a total length of 172 metres, the lock chamber being 97.4 metres long and having an opening 12 metres wide and 4 metres deep. The bottom and foundations are of concrete, the side walls of brick work faced with rubble stone. The harbor is equipped with all modern appliances for the rapid loading and discharging of ships.

The ship canal connecting Bruges and Zeebrügge lies in a straight line and has a total length of 10 kilometres. Its width at the bottom is 22 metres, at the water line 70, and 80.6 between tops of banks. The upper part of the slopes of the banks is protected by flagging held in place by a row of piles. On one side the embankment is 53.5 metres wide and on the other 57 metres. On each bank is a tow path 10 metres wide. The normal depth of water in the canal is 8 metres and the banks rise 1.5 metres above the highest water level.

The outer harbor at Zeebrügge is about 100 hectares in area. It is protected from the danger of silting up and from the influence of strong tidal currents by a wall, 2,487 metres long, built in a circular arc. It exhibits four types of construction. At the shore end is a section 232 metres long which lies entirely out of the water at low tide. On a foundation of concrete 10 metres wide and 1 metre thick, contained in a bed formed of sheet piling, is built a masonry retaining wall 3 metres wide. Against the landward side of this wall is placed the main body of the breakwater, consisting of stone packing to a width, at the top, of 11 metres. The inner side of the packing is sloped 1 in 1½, the toe being held in place by sheet piling and the slopes protected by 40 centimetres of masonry set in cement mortar. On the top of the wall, facing the sea, is built a monolithic concrete breastwork and parapet which bring the total height of the breakwater to 11.8 metres above low water mark. The north end of this section of the breakwater, where the trestle work of the second section begins, is formed by a cross wall of masonry on a concrete foundation. This is protected on all sides by stone packing of the same type of construction as described above, but sloping 1 in 3½ and having outside of it 6 metres of fascine work.

To permit of the circulation of currents due to the ebb and flow of the tide and to prevent the silting up of the approaches to the harbor, the next section of the breakwater, 300 metres long, is of steel trestle work. This trestle is 12 metres wide and carries two lines of rails. Each bent consists essentially of six wrought-steel pile piers, the bents being connected by six horizontal girders. At the end of the trestle is an abutment 18 metres long and 5 metres wide to which the breakwater proper is joined.

The breakwater has a total length of 1,955 metres and is built of concrete blocks. The first part, 1,715 metres long, rests on an immense mass of rubble stone. The lower part of the wall, reaching an elevation of one metre above low water, consists of concrete blocks 25 metres long, 7.5 metres wide, and 7 to 9 metres high, and weighing from 3,000 to 4,000 tons. Above this is a wall of Portland cement blocks 5 metres wide and 6.3 metres high and this carries the final course of ten-ton blocks, the width of the top of the wall being 3 metres and its elevation above high water 8.8 metres. The final part of the breakwater is 226 metres long, of similar but heavier construction. A lighthouse is situated at the extreme end.

The space between the breakwater and the quay wall has been gradually filled with sand as the work progressed and when completed the whole pier will be paved. The quay is 1,721.4 metres long and is of the same general type of construction as the breakwater wall. Alongside the quay there is sufficient depth of water to accommodate ships with a draught of 10 or 11 metres.

The outer end of the canal, joining the lock with the harbor, is 750 metres long.

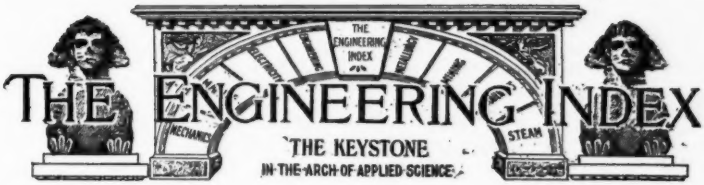
50 metres wide at the bottom and 116 at the top of banks, the vertical distance between these points being 13 metres. The slopes are protected below water by fascine work and above by flagging. The lock has a total length of 282 metres and a length between gates of 256 metres. The length of each crown is 62 metres and the width of the opening 20 metres. A portion of the lock, 158 metres long, is widened to form a basin 25.5 metres wide at the bottom and 38 metres between tops of walls. The depth of water in the lock is normally 9 metres and at flood tide 9.5 metres. The excavation for the lock was made in sandy soil. The bottom is of rammed concrete 21.5 metres wide and 3.5 metres thick, laid in a bed formed by strong sheet piling. The walls are built partly of free-stone masonry, partly of rubble-stone masonry, and partly of brick work laid in trass mortar. The lock is crossed by two electrically-operated drawbridges, one of which carries railway and the other vehicular traffic.

The lock gates are of the rolling type and fit into recesses in the crowns. They are trapezoidal in shape and each consists of a steel caisson, 12.7 metres high and 4.5 in breadth, the length at bottom and top being respectively 20.7 and 24.5 metres. The lower part of each gate caisson is at a depth of 5.9 metres below low-water mark, and the top at a height of 6.8 metres above, thus giving for the top of the gates a height of 0.2 metre above the highest spring tides. Each gate is divided longitudinally into two compartments by a horizontal bulkhead. The lower compartment is made water-tight and contains the steadying ballast. The upper compartment is so arranged as to permit the free circulation of water through the gates when such is desirable. The openings are fitted with sliding-valve sluices and with hanging valves. The object of the arrangement is to allow the water level inside the upper compartment, when the gate closes the lock, to correspond always with the higher level without the gate, alternately on the side towards the open sea or on that towards the canal.

The inner side of the lock opens into the inner harbor which is really an enlargement of the canal. This harbor is 600 metres long, 50 metres wide at the bottom, 96.3 at the water line, and 103.5 between the tops of banks. On the east side is a basin 80 by 150 metres for the accommodation of fishing boats. A quarantine basin, also on the east side is large enough to afford turning space for ships of considerable size. On the south side the dry-dock is located. This is 500 metres long and 100 metres wide at the bottom, the slope of the banks being 2 in 1.

The conception of the scheme is entirely that of the contractors, and we may mention at this point that they have not only built the caissons throughout at their Zeebrügge yard, and successfully floated them out—a fact which in itself would suffice to establish their reputation—but they have both designed and built at Zeebrügge the stone-carrier, all the heavy crane parts, both lock-gates above described, the bridges and the gates of the lock in proximity to the Bruges basin, a suction-dredger, the capacity of which is 750 cubic metres (26,490 cubic feet), the floating crane, the Titan crane, and a number of boats. The remainder of the machines and material, including two excavators for the canal, and the tug-boats, have been built by outside firms to save time, but to the contractors' designs.

Though the harbor works are not yet completed, a considerable and rapidly increasing amount of traffic is being handled, according to a note in a recent number of *Engineering*. "From Oct. 1 to Dec. 31, 1906, there entered 161 ships, measuring 88,948 tons, and carrying 106,113 tons; while 156 ships left, carrying 15,486 tons. Of these ships, 139 were British, 7 Dutch, 6 Norwegian, 3 French, 2 Belgian, and 1 each Swedish, Italian, Danish and German. From January 1 to March 31, of the present year, there entered 146 ships, measuring 68,561 tons, carrying 72,994 tons; and there left 148 ships, carrying 14,570 tons. Of these, 113 were British, 13 Dutch, 11 Norwegion, 5 German, 2 Belgian, 1 Russian, and 1 Swedish." It is probable that when the harbor is completed the excellent arrangements and accommodations for ships will draw a very large amount of traffic and that Bruges will regain a great deal of her lost importance as a commercial center.



The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Abutments.

Methods and Cost of Constructing Concrete Abutments for Two Highway Bridges Over the New York State Barge Canal. Emile Low. Gives a general description of the structures and methods of construction, with costs for the Roberts, and Burdick road bridges, near Oneida Lake. Ills. 1700 w. Engng-Con—May 15, 1907. No. 84364.

Anchorages.

Contractor's Plant and Methods for Constructing the New York Anchorages of the Manhattan Bridge. Rearranged from an article by Charles M. Ripley, with additional matter. Explains the methods employed on the New York side of the river. 2500 w. Engng-Con—May 8, 1907. No. 84275.

Arches.

Some Three-Hinged Concrete Arches

We supply copies of these articles. See page 687.

in Germany. Illustrates and describes bridges of this type in Bavaria. 900 w. Eng News—May 2, 1907. No. 84042.

The Progress in Building Flat, Solid Arches of Long Spans. Extracts from a paper by Herr Liebbrand discussing especially reinforced-concrete structures with hinged arches. Ills. 2000 w. Cement—May, 1907. Serial. 1st part. No. 84555 C.

Birmingham, Eng.

Smallheath Bridge, Birmingham. Plate and illustrated description of an interesting bridge built in connection with a scheme to connect by a thoroughfare the districts of Smallheath and Sparkbrook, and the southern part of the city of Birmingham. It crosses the Great Western Ry. Co.'s lines, and also a canal. 4500 w. Engng—May 10, 1907. Serial. 1st part. No. 84442 A.

Concrete Arches.

Methods and Cost of Constructing the Connecticut Ave. Concrete Arch Bridge at Washington, D. C. Illustrated description of this structure and the methods of construction, giving details of cost of the materials and work. 2800 w. Engng-Con—May 22, 1907. No. 84535.

The Railway Arches of Concrete at Lautrach and Kempten, Bavaria. Illustrates and describes long span, three-hinge concrete arches without reinforcement, carrying railways, recently built across the Iller, a tributary of the Danube River. 1000 w. Eng Rec—May 11, 1907. No. 84323.

Demolition.

The Temporary Vauxhall Bridge. An illustrated account of the demolition of this structure which has spanned the Thames for the last ten years. 1500 w. Engr, Lond—April 26, 1907. No. 84258 A.

Erecting Costs.

Cost of Erecting Two Steel Truss Bridges of 180 ft. Span, and One Plate Lattice Girder Bridge of 100 ft. Span. Gives data not including the cost of erecting the false-work. 700 w. Engng-Con—May 8, 1907. No. 84272.

Foundations.

Bridge Foundations of Ferro-Concrete in the River Foyle. Illustrations, with brief description of piers sunk to foundation level by caissons constructed entirely of ferro-concrete. 400 w. Engng—May 10, 1907. No. 84445 A.

Ganges.

The Report of the Ganges Bridge Committee. Report on three alternative bridge schemes for crossing the Ganges River by railways. 1200 w. Engr, Lond—May 17, 1907. No. 84588 A.

Piers.

The Detailed Cost of a Bridge Pneumatic Caisson and Masonry Bridge Pier Data relating to the cost of labor and materials for three railway bridge piers built by the pneumatic caisson process. 2200 w. Engng-Con—May 8, 1907. No. 84274.

Reinforced Concrete.

Special Bridge Structures for the Track Elevation of the Chicago, Burlington & Quincy Ry. in Chicago. Illustrates and describes the construction of a number of street subway bridges having reinforced-concrete deck-girder floor slabs, built in sections at a distance from the site and afterwards set in place. 3500 w. Eng Rec—May 18, 1907. No. 84426.

The Sandy Hill Bridge Over the Hudson River; A Long Reinforced-Concrete Arch Bridge with Block Facing. An illustrated article outlining methods used in the construction of a bridge of 15 equal arches. Good finish, economy and rapid work were secured. 7700 w. Eng News—May 9, 1907. No. 84290.

Steel Arches.

The Design of a Two-Hinged Spandrel-Braced Steel Arch. Ralph Freeman. Explains the methods of calculation and the general principles of the design of a two-hinged arch. 4800 w. Inst of Civ Engrs, No. 563. No. 84457 N.

Bridge Over the River Usk. Illustrated detailed description of a new bridge of pleasing design, near Abergavenny, England. 700 w. Engr, Lond—April 26, 1907. No. 84261 A.

The Oakland Bridge, Pittsburg, Pa.: A Steel Arch Without Hinges. Willis Whited. Illustrates and describes a no-hinge, long-span steel arch viaduct and the method of erection. 2000 w. Eng News—May 16, 1907. No. 84385.

Suspension.

Suspension Bridges. Brief illustrated descriptions of interesting types. 1500 w. Ry & Loc Engng—May, 1907. No. 84030 C.

Viaducts.

Survey Work for a Two-Mile Viaduct, Key West Extension of the Florida East Coast Ry. George P. Carver. An illustrated description of methods employed in locating points and giving lines and grades for piling and concrete forms for nearly 200 piers. 2700 w. Eng News—May 9, 1907. No. 84291.

The Jacksonville Viaduct. A reinforced-concrete structure 845 ft. long and 60 ft. wide, carrying a highway, two street-car tracks, and two sidewalks, is illustrated and described. 1800 w. Eng Rec—May 18, 1907. No. 84428.

CONSTRUCTION.

Anchorages.

The Anchorages of the Singer Build-

We supply copies of these articles. See page 687.

ing Tower. Illustrates and describes the vertical steel anchorages for the tower, 612 ft. above the curb, built in as the concrete was made, in such a manner as to utilize the full weight of the pier. 1200 w. Eng Rec—May 4, 1907. No. 84221.

Building Details.

Steel Details in the Upper Part of the Singer Building Tower. Illustrated description of dome, beam and floor framing. 1800 w. Eng Rec—May 25, 1907. No. 84567.

Structural Details in the Singer Building, New York. Illustrates and describes details of columns which support the superstructure; also wind bracing details, and other interesting work. 2800 w. Eng Rec—May 18, 1907. No. 84427.

Columns.

Reinforced-Concrete Columns. Gives types of such columns, with notes on the assumptions used in their design, showing what has already been done. 2200 w. Engr, Lond—April 19, 1907. No. 84005 A.

Concrete.

Expansion Joints in Concrete Structures, with Special Reference to Block Construction in Drydocks and Reservoirs. L. F. Bellinger. Explains an approximate method of computing the amount of steel necessary to take up the thermal and shrinkage stresses, giving examples of contraction and expansion, and presents a proposed system of block construction. 5500 w. Eng News—May 2, 1907. No. 84040.

The Commercial Value of Shop Drawings for Concrete Structures. Shows the importance of careful preparation of shop drawings and the setting plans, and their value in saving time and material. 2500 w. Munic Engng—May, 1907. No. 84,046 C.

Contractor's Plant.

The Contractor's Plant Used in Constructing the Montgomery Ward Building, Chicago. Outlines the conditions under which an 8-story reinforced-concrete building was constructed, in restricted location, illustrating and describing the plant for carrying on the work. 3800 w. Eng Rec—May 11, 1907. No. 84321.

Dam.

A Large Reinforced-Concrete Dam at Ellsworth, Me. Brief description of a dam under construction which has probably the highest head of any structure of this type yet attempted. 1000 w. Eng News—May 23, 1907. No. 84492.

The Dhukwa Dam. Illustrated detailed description of a project for building a dam across the Betwa River in India, giving the interesting features and information of interest. 3000 w. Engr, Lond—May 17, 1907. No. 84585 A.

Demolition.

The Demolition of the Great Wheel. An illustrated account of the methods used in this difficult and interesting engineering work. Plate. 3500 w. Engng—April 26, 1907. No. 84252 A.

Drills.

Well Drills for Blast Holes on the Panama Canal. An illustrated account of work done by the use of well drills, air driven. 1700 w. Compressed Air—May, 1907. No. 84533.

Excavation.

Hydraulic Excavation in Seattle with a Motor-Driven Turbine Pump. George Holmes Moore. Describes the plant used for the reduction of Denny Hill. Ills. 900 w. Eng News—May 16, 1907. No. 84387.

Factories.

An Example of Recent Factory Construction. Robert I. Clegg. Illustrated detailed description of the Automobile Works of the White Co., recently built at Cleveland, Ohio. 2500 w. Ir Age—May 2, 1907. No. 84028.

The New Factory Building of the Murphy Varnish Co. William F. Burleigh. A reinforced concrete building erected at Newark, N. J., of interest because of the unusual style of architecture for factory construction. A mansard roof. 1800 w. Eng Rec—May 4, 1907. No. 84227.

Failures.

Unexpected Accidents (Accidents Inopinés). Paul Sée. Examples of failures of various types of structures, due to causes which could not have been provided for. 3500 w. Mem. d. l. Soc. d. Ing Civ d France—March, 1907. No. 84102 G.

Floors.

Ferro-Concrete Floors at the Waldorf Hotel, Aldwych, London. Illustrates and describes typical sections of these fire-proof floors. 1400 w. Engng—April 19, 1907. No. 84002 A.

Foundations.

Concrete Foundations of the Tallest Skyscraper. Charles M. Ripley. Illustrated description of the methods employed for the Singer Building, the site of which is underlaid with a marshy soil, part quicksand and soft mud. 2500 w. Cement—May, 1907. No. 84556 C.

Perrons.

Foundations for Concrete and Reinforced-Concrete Perrons (Unterbau von Freitreppen in Beton und Eisenbeton). Herr Weidmann. Mathematical discussion of their design and calculation. Ills. 3000 w. Serial. 1st part. Deutsche Bauzeitung—April 24, 1907. No. 84139 D.

We supply copies of these articles. See page 687.

Piling.

Methods and Cost of Operating Pile Drivers and Driving Steel Sheet Piling. A paper by William A. Fargo, read before the Mich. Engng. Soc., with additional data on the cost of steel sheet piling work. Ills. 3000 w. Engng-Con—May 1, 1907. No. 84071.

Reclamation Work.

Building a Town Site by Suction Dredge. Day Allen Willey. Illustrated description of interesting work at Cape May, N. J., by which a salt marsh is being filled, giving an area sufficient for 7500 dwellings, in addition to necessary streets. 1500 w. Sci Am—May 25, 1907. No. 84546.

Reinforced Concrete.

Reinforced Concrete Construction. Gunvald Aus. On the necessity of constant inspection of every detail to insure a safe construction, the importance of design, etc. 1600 w. Am Archt—May 4, 1907. Special No. No. 84361 E.

Reinforced Concrete Construction in California. Horatio F. Stoll. A brief review of the concrete work now under way in rebuilding of the districts on the Pacific Coast destroyed by the earthquake and fire. Ills. 2200 w. Cement Age—May, 1907. No. 84554.

Reinforced Concrete in Spain (Le Béton Armé en Espagne). J. E. Ribera. Describes bridges, aqueducts and a siphon of reinforced concrete now under construction. Ill. 5000 w. Mem. d. l. Soc. d. Ing. Civ. d. France. March, 1907. No. 84103 G.

The Coal Pockets of the Salem Mines. A structure of reinforced concrete, of rather unusual character recently built at Alexandria, Pa., is illustrated and described. 1000 w. Eng Rec—May 4, 1907. No. 84226.

Largest Concrete Machine Shop in the World. L. P. Alford. Illustrates and describes the buildings and methods of construction of the new plant of the United Shoe Machinery Co., at Beverly, Mass. 4500 w. Am Mach—Vol. 30. No. 21. No. 84488.

Reinforced-Concrete Construction on the New Building of the Vienna Board of Trade (Eisenbeton-konstruktionen am Neubau der Wiener Handels- und Gewerbekammer). Karl Rössle. A mathematical discussion of the design of this 8-story building. Ills. 1800 w. Beton u Eisen—April, 1907. No. 84186 F.

Roofs.

The New Roof Over Charing Cross Terminal Station, London. Charles S. Lake. A general illustrated description of this new roof, now nearing completion. 1200 w. Eng Rec—May 11, 1907. No. 84325.

San Francisco.

The Effects of the Earthquake and Fire on Steel Structures in San Francisco (Die Wirkungen von Erdbeben und Feuer auf die Eisenkonstruktionen in San Francisco). Prof. Kohnke. Gives the conclusions reached by the writer after personal investigation. Ills. 2700 w. Stahl u Eisen—April 24, 1907. No. 84130 D.

Society Buildings.

The Engineering Societies Building in New York. An illustrated article comparing this new building, its arrangements and facilities, with those of some of the buildings, devoted to similar purposes, in other parts of the world. 2500 w. Cassier's Mag—May, 1907. No. 84048 B.

Structural Engineering.

Some Commercial Features of Structural Engineering. Emil Gerber. Also discussion. Discusses briefly the materials, design, and some details of construction. 8000 w. Pro Engrs' Soc of W Penn—April, 1907. No. 84027 D.

Workmen's Homes.

The Construction of Employees' Homes by German Electric Railways. An illustrated article giving designs and suggestions for homes for workmen, taken from an elaborate work issued by the Prussian Minister of Public Works. 3000 w. St Ry Jour—May 4, 1907. No. 84229.

MATERIALS OF CONSTRUCTION.

Brick.

Sand-Lime Brick. E. W. Smythe. Read before the Wis. Clay Workers' Association. Reviews the history of this material and its use, describing the processes of manufacture used by different workers. 1800 w. Sci Am Sup—May 25, 1907. No. 84548.

Cement.

The Economy of the Long Kiln. E. C. Soper. Gives results of tests on 7′ x 60′ and 8′ x 110′ rotary kilns burning natural gas, discussing the kiln question. 1300 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84641 F.

Columns.

Tests of Concrete and Reinforced Concrete Columns; Series of 1906. Arthur N. Talbot. An illustrated account of the materials, test pieces and methods of testing, with experimental data and discussion. 16000 w. Univ of Ills Bul—Feb. 1, 1907. No. 84589 N.

Concrete.

Concrete Walls and Floors. E. P. Goodrich. Discusses some of the points involved in the use of reinforced concrete, especially for walls and floors, explaining some of the characteristics of

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this material. 4000 w. Am Archt—May 4, 1907. Special No. No. 84360 E.

Concrete Failures. John J. Flather. Briefly considers the causes of failure, discussing the important examples. Ills. 4000 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84632 N.

Notes on Expansion and Contraction of Concrete Structures. A. C. Lewerenz. Observations as to the effect of expansion and contraction on concrete and reinforced concrete and reinforced concrete structures made at a U. S. Navy Yard. Also editorial. Ills. 2400 w. Eng News—May 9, 1907. No. 84295.

The Laws of Proportioning Concrete. Interesting statements presented by Sanford E. Thompson, supplementing a paper read before the Am. Soc. of Civ. Engrs. on April 17. 4000 w. Eng Rec—May 11, 1907. No. 84324.

The Architectural Problem of Concrete. A symposium on the artistic design of reinforced-concrete and concrete structures, giving the opinions of many architects. 13500 w. Am Archt—May 4, 1907. Special No. No. 84358 E.

The Idiomatic Use of Concrete. Evarts Tracy. A brief discussion of the laws governing the use of concrete from the artistic viewpoint. 1200 w. Am Archt—May 4, 1907. Special No. No. 84359 E.

Iron Columns.

Three Tests of Iron Columns (Drei Versuche mit Eisensäulen). Fritz v. Emperger. Flexure tests of columns built up of angles and double T irons. Ills. 2500 w. Beton u Eisen—April, 1907. No. 84187 F.

Plaster.

Process of Producing Bubbleless Plaster. Describes a process of mixing plaster with water so as to exclude all air. 1100 w. Sci Am Sup—May 11, 1907. No. 84331.

Slaking a Plaster and Means of Retarding Its Hardening. Gives hints from practice. 1500 w. Sci Am Sup—May 11, 1907. No. 84329.

Reinforced Concrete.

Engineering Advice as to Reinforced Concrete. Report of the Committee on Architecture, Illinois Society of Engineers and Surveyors. 2000 w. Am Archt May 4, 1907. Special No. No. 84362 E.

Reinforced Concrete: Its Limitations. Carl Gayler. A discussion of this material, the effects of shrinkage, details of construction, etc. Ills. 5000 w. Jour of Engng Socs—April, 1907. No. 84527 C.

Reinforced-Concrete Structures for Manufacturing Purposes. Leonard C. Wason. An illustrated article presenting the advantages of this material and its economy. 2500 w. Engineering Magazine—June, 1907. No. 84195 B.

Experiments on the Effects of Stress in Reinforced-Concrete Beams (Versuche über die Schubwirkungen bei Eisenbetonträgern). Emil Mörsch. Paper read before the Deutscher Beton-Vereins, describing the results of elaborate experiments to determine the way in which reinforced-concrete beams usually fail. Ills. 7000 w. Serial, 3 parts. Deutsche Bauzeitung—April 13, 20, May 1, 1907. No. 84138 each D.

Timber.

Methods and Economic Aspects of Modern Timber Preservation. Gellert Alleman. Gives statistics of the amount of timber used in a year, and the per cent. treated; describes briefly the methods of treatment, the life and cost, discussing economic considerations, injury caused by treatment, etc. Discussion. Ills. 10500 w. Pro Engrs' Club of Philadelphia—April, 1907. No. 84525 D.

Preservation of Mine Timber from Decay. John M. Nelson. Reviews experimental work conducted by the Philadelphia & Reading C. & I. Co., and U. S. Forest Service, showing how the life of timber may be prolonged. Ills. 1000 w. Eng & Min Jour—May 4, 1907. No. 84213.

The Powell Process of Preserving Wood with Saccharine. Illustrated description of this process which is simple, inexpensive and said to be efficient. 2200 w. Sci Am Sup—May 11, 1907. No. 84333.

The Preservation of Woods by the New Methods of Impregnation (La Conservation des Bois par les Nouvelles Méthodes d'Imprégnation). E. Lemaire. Discusses the causes of the decay of wood and the natural and artificial methods used to preserve it; describing principally the impregnation processes and the effects of the chemicals used in them. 5000 w. Génie Civil—April 13, 1907. No. 84113 D.

The Preservation of Railway Ties (La Conservation des Traverses de Chemins de Fer). A summary of the results of experiments on the heat-conducting qualities of wood with a view to determining the value of raising the wood to high temperatures before impregnation with preservative solutions. 3000 w. Génie Civil—April 27, 1907. No. 84118 D.

MEASUREMENT.

Surveying.

Methods of Surveying on New York State Roads. Information from a manual issued by Henry A. Van Alstyne concerning the methods used. 2500 w. Eng Rec—May 25, 1907. No. 84566.

MUNICIPAL.

Fire Apparatus.

Fire Prevention Apparatus. John

Richards. Suggests a fire boat or barge provided with units of rotative pumping apparatus, and other features. With special reference to San Francisco and its needs. Discussion. 3500 w. Jour Assn of Engng Socs—April, 1907. No. 84528 C.

Garbage.

Two Years' Operations of the Municipal Garbage Reduction Works, Cleveland, O. Gives figures on the cost of garbage collection and disposal. 4000 w. Eng News—May 2, 1907. No. 84044

Harbor Pollution.

The Pollution of New York Harbor. George C. Whipple. Map and explanation of present conditions, with a study of important phases of sewage disposal at New York. 5400 w. Eng News—May 23, 1907. No. 84499.

Pavements.

Modern Methods in Cement Paving. H. L. Weber. Read before the Assn. of Am. Cement Mfrs. Gives details and cost data in the construction of streets and sidewalks with concrete foundations. Specifications and letters are given. 5000 w. Cement Age—May, 1907. No. 84553.

The Maintenance of Asphalt Pavements. S. Whinery. Discusses the most economical method of keeping asphalt pavement in repair. 5000 w. Eng News—May 9, 1907. No. 84294.

Public Health.

Public Health and the Future of Paris (Santé Publique et Paris de Demain). Gaston Trélat. Paper read at the convention of the National Academy of Arts and Crafts. Discusses the sources of danger to public health and the problems which confront Paris. Ill. 8000 w. Rev Gen des Sci—April 15, 1907. No. 84-109 G.

Roads.

Methods and Cost of Constructing and Maintaining Oyster-Shell Roads. Josiah Miller. Information relating to the construction and maintenance of shell roads and the cost. 2200 w. Engng-Con—May 1, 1907. No. 84070.

Methods and Cost of Tarring Macadam and Clay Roads in South Haven, Mich. Charles R. Wrightman. Describes methods and gives suggestions based on experience. 1500 w. Engng-Con—May 8, 1907. No. 84273.

Some Notes on Tractive Force on Roads. Discusses results of experimental tests. 2500 w. Prac Engr—May 10, 1907. No. 84436 A.

Septic Tanks.

Recent Septic Tanks. Illustrated descriptions of reinforced-concrete plants at Newton, N. J., and at Belleville. Ills. 1000 w. Munic Jour & Engr—May 1, 1907. No. 84034 C.

On the Question of the Importance of Septic Tanks for Biological Water Purification (Zur Frage von der Bedeutung des Septiktanks für die biologische Abwasserreinigung). Dr. S. K. Dzierzgowsky. The first part of the serial gives several tables of elaborate records of the action of septic tanks in water purification made from tests at Tsarskoje Sselo. Ills. 16500 w. Serial. 1st part. Gesundheits Ing.—April 27, 1907. No. 84185 D.

Sewage.

A Description of the Recently Installed Sewage Disposal Works for the Village of Balliston Spa, New York. G. L. Robinson. Detailed description with illustrations and explanation of the character of the sewage. 2800 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84561 E.

The Admission of Trade Wastes into Sewers of Reading, Pa. An account of an investigation made and the conclusions reached, describing the character of the wastes and giving the classification made. 2200 w. Eng Rec—May 25, 1907. No. 84564.

Sewerage Construction Work. Describes some of the machinery being adopted for this work. Excavators, conveyors, etc. Ills. 2500 w. Munic Jour & Engr—May 1, 1907. No. 84032 C.

Sewerage Pumps and Lifts. Illustrates and describes centrifugal pumps, ejectors, and lifts. 3300 w. Munic Jour & Engr—May 1, 1907. No. 84033 C.

Sewers.

Method of Constructing a 6-ft. Sewer Siphon Under a 16-ft. Conduit, Chicago, Ill. Illustrates and describes an interesting piece of work executed recently in connection with the construction of the Intercepting Sewer System. 700 w. Engng-Con—May 22, 1907. No. 84536.

Reinforced Concrete Sewers and Conduits, in the United States of America. Ernest Romney Matthews. Illustrates and describes a number of sewers and conduits which have been constructed on this principle in American cities. 3800 w. Inst of Civ Engrs, No. 3645—No. 84459 N.

Street Cleaning.

Street Cleaning in the Central Business District of Chicago. An illustrated article explaining the work done by the Citizens' Street Cleaning Bureau, and stating the conditions and cost. 4800 w. Eng Rec—May 25, 1907. No. 84565.

WATER SUPPLY.

Albany, N. Y.

Improvements to the Water Supply System of Albany, N. Y. Information in regard to the new filter plant and in-

crease in capacity of the Quackenbush St. pumping station. Ills. 1200 w. Eng Rec—May 18, 1907. No. 84430.

Aqueduct.

Repairing a Limestone Concrete Aqueduct. Michael Ratcliffe Barnett. An account of the leakage in the Thirlmere aqueduct, which conveys water to Manchester, Eng., due to deterioration of the concrete, resulting from the action of water on the limestone with which the concrete was made. Ills. 7500 w. Inst of Civ Engrs, No. 3636—No. 84466 N.

Drainage-Areas.

The Yield of Catchment-Areas. Ernest Prescot Hill. Suggests a system of observations to obtain information upon which the design of water-works can be based. 2200 w. Inst of Civ Engrs, No. 3641—No. 84467 N.

Edinburgh.

The Talla Water-Supply of the Edinburgh and District Water-Works. William Archer Porter Tait. An account of this scheme and its execution, which increases the supply at a cost of £1,250,000. 15000 w. Inst of Civ Engrs, No. 3611—No. 84465 N.

Filtration.

Notes on Water Filtration in Japanese Cities. George A. Johnson. Notes on the Tokyo water-works, and the Osaka works, with illustrations. 4000 w. Eng Rec—May 11, 1907. No. 84318.

Operation of the New Haven Water Co.'s Filter Plant. Charles A. Ferry. Read before the Conn. Soc. of Engrs. Reports the operation of the Whitneyville filtration plant which supplies about 8,500,000 gals. per day. 3000 w. Eng News—May 9, 1907. No. 84293.

Sand Filters at Bar Harbor, Me., and South Norwalk, Conn., for the Removal of Organisms, Tastes and Odors from Water. H. W. Clark. Brief illustrated descriptions of these filters. 1600 w. Eng News—May 23, 1907. No. 84493.

The American System of Filtration Plant at Damietta, Egypt. Edmund B. Weston. Outlines the history of this town, and briefly describes its former water-works, giving an illustrated description of the new plant. 2500 w. Eng Rec—May 4, 1907. No. 84220.

Hong Kong.

The Tytam Tuk Water-Works, Hong Kong. D. Jaffé. Illustrated description of new works in progress to increase the water supply. The new reservoir is 200 ft. below the level of the inlet to the tunnel of the original works, and the water is pumped. 1800 w. Eng Rec—May 25, 1907. No. 84562.

Irrigation.

Egyptian Irrigation and the Assuan Dam. Information contained in a recent despatch from Lord Cromer concerning the benefits this reservoir has conferred on Egypt, and matters related. 2500 w. Engr, Lond—April 26, 1907. No. 84260 A.

Koeta Radja.

The Procuring of Pure Water at Koeta Radja (De Drinkwatervoorziening van Koeto Radja). H. Heetjans. Illustrated description of the project, tunnel, canal, etc. 7000 w. De Ingenieur—April 13, 1907. No. 84190 D.

New York City.

Progress on New York City's Catskill Water Supply System: Dams of the Ashokan Reservoir. Map, illustrations and outline of the plans for increasing the supply by 500,000,000 gals. per day. 1000 w. Eng News—May 9, 1907. No. 84296.

Pipe Lines.

On a More Economical Profile for Pressure Conduits of Iron or Steel Plates (Sul Profilo piu Economico delle Condotte Forzate in Lamiera di Ferro o d'Acciaio). A. Anastasi. Mathematical Paper. Plate. 7000 w. Ami della Soc Ing e d Arch Ital—Vol. XXI, No. 3. No. 84127 F.

Pipe Sizes.

A Solution of the Problem of Determining the Economic Size of Pipe for High-Pressure Water-Power Installation. Arthur L. Adams. Gives a solution worked out by the author stating the assumptions upon which it is based. 900 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84560 E.

Graphic Methods of Calculating Conduits for Gas, Air, and Water (Abaques pour le Calcul des Conduites de Gaz, d'Air et d'Eau). A. Grebel. Mathematical explanation of the methods illustrated by examples. Ills. 2500 w. Génie Civil—April 13, 1907. No. 84114 D.

Pumping-Station.

A Rock-Cut Bomb-Proof Pumping Station at Gibraltar. Albert Wilson. Describes a station built to make secure, in time of war, the supply of water for sanitary and domestic use. 1500 w. Inst of Civ Engrs, No. 3528—No. 84460 N.

Reservoirs.

New Reservoirs at Walton. Leading particulars, with illustrations, of two large reservoirs under construction on the south side of the Thames. 1600 w. Engr, Lond—April 19, 1907. No. 84007 A.

Run-Off.

Comparison Between Rainfall and Run-off in the Northeastern United States. John C. Hoyt. A study based on information collected by the U. S. Government, and by private parties, in regard to precipitation and stream run-off. Tables and map. 2500 w. Pro Am Soc of Civ Engrs—May, 1907. No. 84559 E.

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Rust.

Rust in Water Pipe Lines and Means of Prevention (Rost in Wasserleitungen, Schutz- und Vorbeugungsmittel). H. Wehner. The first part discusses the agencies which cause rusting of iron pipes and the effect of atmospheric conditions. Ills. 11000 w. Serial. 1st part. Gesundheits Ing—April 20, 1907. No. 84184 D.

Sluice.

Automatic Sluice in the Bondman Weir Across the Aire at Leeds. Illustrated description of this work executed in connection with sanitary measures on the River Aire. 1400 w. Engng—May 17, 1907. No. 84579 A.

Treatment.

Experiments on the Preliminary Treatment of Water at Washington, D. C. A report of experiments being carried on by the engineers of the filtration plant, which is of the slow-sand type. 2000 w. Eng Rec—May 25, 1907. No. 84568.

Water Supply.

Discussion on Water Supply. Discussion of papers by Messrs. Tait, Barnett, and Hill. 31000 w. Inst Civ Engrs—Nov. 27, and Dec. 11, 1906. No. 84468 N.

Water-Works.

Water-Works Constructions in America. Ernest Romney Matthews. Detailed description of American methods of design and construction of such works. Ills. 4500 w. Soc of Engrs—May 6, 1907. No. 84485 N.

The New Water-Works at Wilmington, Del. An illustrated article describing the new reservoir, and slow-sand filters, new pumping plant, force and distribution mains, and the reinforced-concrete Van Buren St. bridge. 3800 w. Eng Rec—May 4, 1907. No. 84225.

WATERWAYS AND HARBORS.

Breakwater.

The Stone Breakwater at Cleveland, O. George H. Cushing. Illustrates and describes a modification in the form of construction of the stone masonry portion of the breakwater, as recommended by Lt.-Col. Curtis McD. Townsend. 1500 w. Eng News—May 23, 1907. No. 84496.

Canals.

The Kaiser Wilhelm Canal. Describes briefly the methods proposed to increase the efficiency of this canal, stating the existing conditions. 1200 w. Engr, Lond—May 3, 1907. No. 84346 A.

Coast Protection.

The Protection of Sea Shores from Erosion. Alfred Edward Carey. Gives examples of the magnitude of wave force, with description of the coasts of the British Isles and the methods of protecting them, and offering suggestions. General discussion. Ills. 12500 w. Jour Soc of Arts—May 3, 1907. No. 84334 A.

Derrick.

A Floating Derrick for Handling Heavy Rip-Rap Stone. Illustrated description of a floating derrick and grapple specially designed for the harbor work at Superior Entry, Wis. 1200 w. Eng News—May 23, 1907. No. 84494.

Docks.

The Rothesay Dock at Glasgow. An illustrated description of the construction and equipment of this new dock, electricity having been adopted as the motive power. The dock was built to relieve the congestion of traffic at the mineral quays. 5400 w. Engng—April 26, 1907. No. 84253 A.

Levee.

The Construction of the Levee Below the Recent Colorado River Break. C. W. Ozias. Describes the soil and general conditions and gives an illustrated description of the methods of levee construction. 1800 w. Eng News—May 16, 1907. No. 84389.

Madoera.

Report on the Improvement Work at the West Opening of the Strait of Madoera (Bescheiden Betreffende de Verbetering van het Westgat van Straat Madoera). H. Wakkie. 12000 w. De Ingenieur—April 27, 1907. No. 84189 D.

North Sea.

The North Sea: Its Physical Characteristics, Tides and Currents. W. H. Wheeler. Map and information in regard to the dimensions, coast line, and general formation. 3500 w. Engr, Lond—May 17, 1907. No. 84582 A.

Piers.

Cement Piers. Illustrates and describes the cement cylinder piers used for dock construction at San Francisco, and on the Pacific coast, stating the methods of construction. 600 w. Sci Am Sup—May 25, 1907. No. 84550.

The Collapse of the Locust Point Pier, Baltimore. An illustrated account of the collapse of a pier in an advanced stage of construction. 1200 w. Eng Rec—May 11, 1907. No. 84319.

Salton Sea.

The Colorado River Closure. W. D. H. Washington. An account of the cause of the breach which caused the flooding of the Salton Sink, and of the methods tried in effecting a closure. Ills. 3000 w. Sci Am—May 4, 1907. No. 84081.

MISCELLANY.

Address.

Presidential Address of Sir Alexander B. W. Kennedy. On the engineer, his relation to science, art, nature, law, commercial, professional and industrial life,

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etc. 11000 w. Inst of Civ Engrs—Nov. 6, 1906. No. 84470 N.

Asbestos Wood.

New Fire Retardant. Prof. Charles L. Norton. Describes tests made of asbestos wood, a non-inflammable material that can be worked with ordinary tools. Ills. 2200 w. Ins Engng—April, 1907. No. 83957 C.

Dam.

The San Roque Dam (Dique de San Roque). Daniel E. Gavier. Report of an investigation of the condition of stability of this dam in the Argentine Republic. Ill. 4500 w. Serial. 1st part. La Ingeneria—Feb. 28, 1907. No. 83996 D.

Earth Slip.

Earth Slip at the Viaduct of the Gor, Spain (Glissemeut de Terrain au Viaduc du Gor, Espagne). Arséne Portier. A description of the causes and effects of earth-slip under one of the abutments of a bridge between Grenada and Murcie, Spain. Ill. 4000 w. Mem. d. l. Soc. d. Ing. Civ. l. France—March, 1907. No. 84104 G.

English Channel.

Channel Tunnels, Bridges and Ferries. Reviews the various projects for constructing a tunnel under the Straits of Dover, for the laying of submerged tubes and roadways for ferries carrying the trains, and for bridges across the Channel. Also editorial. 5000 w. Engr, Lond—March 22, 1907. No. 83427 A.

Hauling Crops.

Costs of Hauling Crops from Farms to Shipping Points. Frank Andrews. Condensed from Bul. 49, Bureau of Statistics, U. S. Dept. of Agri. Information obtained through inquiries sent out. Editorial discussion. 4800 w. Eng News—April 18, 1907. No. 83892.

Ideals.

Professional Ideals of the Twentieth Century. Address of President Hadley of Yale University at the dedication of the Engineering Societies Building in New York. 3000 w. Eng Rec—April 20, 1907. No. 83834.

Rainfall.

Salton Sea and the Rainfall of the Southwest. Alfred J. Henry. An examination of the conditions showing it to be very doubtful that any local evaporation increases the rainfall. 2200 w. Nat Geog Mag—April, 1907. No. 83854 C.

Reclamation.

Reclaiming the Swamp Lands of the United States. Herbert M. Wilson. An interesting account of the many swamps in the United States, what has been done in draining them, and work proposed. Ills. 4000 w. Nat Geog Mag—May, 1907. No. 84455 C.

Roof Collapse.

The Collapse of Concrete Roof Arches at the Lawrence Filter. John F. O'Connell. An illustrated account of the recent collapse of the groined concrete roof arches, thought to be due to the action of frost before the concrete had set. Also editorial. 2500 w. Eng Rec—April 27, 1907. No. 83947.

Tin Roofs.

Fire Resistance of Tin Roofing. Edwin L. Seabrook. A study of its fire-protecting qualities giving instances where it prevented the fire from spreading. Ills. 1500 w. Ins Engng—April, 1907. No. 83958 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

Steno-Telegraphy. A descriptive account of a new development intended to effect a degree of economy and efficiency in submarine cable transmission. 2500 w. Elect'n, Lond—May 10, 1907. No. 84439 A.

Dictating Machine.

Telephone Dictating Apparatus. Describes a recently invented telephone dictating machine by which a person may dictate to any one of his stenographers without requiring them to leave their desk. Ills. 1200 w. Sci Am Sup—May 11, 1907. No. 84330.

Electric Waves.

The Silicon Detector, and Measurement of Electric Wave Energy. William Meaver, Jr. Describes the Pickard detector, which is of the thermo-electric type of wireless receivers, and tests made with it. 900 w. Sci Am Sup—May 25, 1907. No. 84547.

Poles.

The Sterilization and Preservation of Telephone and Telegraph Poles. H. P. Folsom. Abstract of an address before the Ohio Ind. Tel. Assn. Gives an estimate of the number of poles used in the United States, and their value, discussing the cause of decay and the remedy. 1500 w. Elec Rev, N Y—May 4, 1907. No. 84097.

Radiotelegraphy.

A Military Wireless Telegraph Equipment. A. Frederick Collins. Illustrates and describes the various kinds of field equipment and the arrangements for

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transporting it. 1200 w. Sci Am—May 4, 1907. No. 84080.

A New Government Portable Wireless Telegraph Apparatus. R. H. White. Illustrated detailed description of an outfit that can be carried on the backs of three mules. 2000 w. Elec Rev, N Y—May 25, 1907. No. 84606.

Automatic Calling Device for a Wireless Telegraph System. W. R. Carroll. Describes the equipment of the station at Yerba Buena Island, San Francisco Bay, especially the auto-sender and its operation. 1000 w. Elec Wld—May 25, 1907. No. 84610.

Telegraphy.

The Rowland Telegraphic System. Louis M. Potts. Describes a system which provides for an increased wire capacity, combined with greater efficiency of the operator and adaptability to present-day requirements. It combines multiplexing and printing. Ills. 8800 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84511 D.

Telephony.

Fleet Telephony. Bradley A. Fiske. Explains a scheme for maintaining communication by telephone between the various vessels during fog. 1400 w. Pro U S Nav Inst—March, 1907. No. 84025 F.

Telephonic Transmission Measurements. B. S. Cohen. Describes results obtained in the investigation laboratory of the National Telephone Co., which include methods of measuring frequency, distortion, attenuation, current and power of telephone waves, and also line and instrument impedances. 5500 w. Inst of Elec Engrs—May 9, 1907. No. 84480 N.

The Home Telephone Company, Ironton, Ohio. Illustrated detailed description of a new automatic central energy system. 3000 w. Elec Rev, N Y—May 4, 1907. No. 84098.

Telephotography.

The Electrical Transmission of Pictures (La Transmission Electrique des Images). M. Henry. A review of the researches on the subject leading up to descriptions of the work of Fowler and Korn. Ill. Serial. 1st part. 3500 w. L'Elec'n—April 20, 1907. No. 84106 D.

DISTRIBUTION.

Compensators.

Direct Current Compensators for Balancing Electric Circuits. H. M. Biebel. Describes a device whereby one or more neutral wires can be introduced into a two-wire circuit, making it possible to obtain circuits of proportional lower voltage. Ills. Discussion. 5000 w. Jour W Soc of Engrs—April, 1907. No. 84532 D.

Conductors.

Drawing Conductors into Conduit. T. W. Poppe. Describes methods used in drawing in conductors after the conduit work is complete. 1200 w. Elec Wld—May 4, 1907. No. 84207.

Economical Conductor Section. Frank G. Baum. Discusses the method of determining the most economical size of conductor for a certain case. Considers the value of Kelvin's law. Also editorial. 2500 w. Elec Wld—May 25, 1907. No. 84608.

"Flexibles."

"Flexibles," with Notes on the Testing of Rubber. Prof. Alfred Schwartz. Discusses fire risks from flexibles, conductors, heating due to excessive currents, insulation, oxidation of rubber, effect of high temperature, tests, flexible wiring system, etc. 19000 w. Inst of Elec Engrs—April 18, 1907. No. 84010 N.

French Legislation.

French Legislation on Electric Distribution. Editorial on legislation dealing with distribution within the limits of private properties, and transmission along and across public thoroughfares. 1500 w. Engng—April 26, 1907. No. 84256 A.

Fuses.

Theoretical and Practical Points in Connection with Safety Fuses (Theoretisches und Praktisches über Abschmelzsicherungen). Georg J. Meyer. The first instalment gives a mathematical discussion of fuses and considers various materials from which fuses may be made giving results of tests. Ills. 4000 w. Serial. 1st part. Elektrotech Zeitschr—April 25, 1907. No. 84174 D.

Transformers.

Forced-Oil and Forced-Water Circulation for Cooling Oil-Insulated Transformers. C. C. Chesney. Short paper introductory to a discussion. 500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84515 D.

Relative Advantages of One-Phase and Three-Phase Transformers. John S. Peck. Considers the various advantages and disadvantages of a three-phase transformer as compared with a group of three one-phase transformers whose aggregate output is the same. Introductory to a discussion. 1600 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84514 D.

Relative Merits of Three-Phase and One-Phase Transformers. H. W. Tobey. Short paper to introduce discussion, outlining the two systems and pointing out the advantages and limitations of each. 800 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84513 D.

Wiring.

Enclosed Station Wiring. F. O. Blackwell. Introduction to a discussion. Gives photographs showing high-potential arcs. 500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84516 D.

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DYNAMOS AND MOTORS.

Alternating Current.

The Alternating-Current, Compound-Wound Motor of the Felten & Guilleaume-Lahmeyer Works (Die Wechselstrom-Doppelschluss-Motor der Felten & Guilleaume-Lahmeyerwerke). M. Osnos. Illustrated detailed description of this type of motor, explaining its great value for hoisting purposes. 7000 w. Two articles. Elektrotech Zeitschr—April 11 and 18, 1907. No. 84172 each D.

Direct-Current.

Notes on the Characteristic Curves of the Direct-Current Machine. Harrison W. Smith. Notes found useful in discussing the action of the direct-current machine. 3000 w. Tech Qr—March, 1907. No. 84474 E.

Inductive Motors.

The Induction Motor. C. J. Spencer. A discussion of the induction motor, the functions of the secondary, and methods of calculating the resistance, and related matters. 2800 w. Elec Age—May, 1907. Serial. 1st part. No. 84621 C.

Protection.

Protection of Motors in Dusty Places. Kingsley Williams. Illustrates and describes various methods of housing and ventilating motors. 800 w. Elec Wld—May 4, 1907. No. 84208.

Two-Pole.

Two-pole A. C. Machines with Constant and Separately Excited Fields, a Contribution to the Construction of Turbo-generators (Zweipolige Wechselstrom-Maschinen mit feststehendem Felde und verketteter Erregermaschine, ein Beitrag zum Bau der Turbodynamos). A. Heyland. Theoretical and mathematical discussion of their design. Ills. 5000 w. Elektrotech Zeitschr—April 11, 1907. No. 84170 D.

Variable Speed.

A New Variable Speed Motor. Benjamin F. Bailey. Describes a simple method by which either all or one-half of the armature conductors can be connected, thus giving two normal speeds, one twice as great as the other. Also editorial. 2500 w. Elec Wld—May 11, 1907. No. 84311.

ELECTRO-CHEMISTRY.

Electro-Metallurgy.

The Electrometallurgical Industries in 1907. John B. C. Kershaw. Reviews the progress of these industries during the past year, and their position at the present time. Ills. 4500 w. Cassier's Mag—May, 1907. No. 84049 B.

Electrolytic Lead Refining and Treatment of Slimes and By-Products. A. G. Wolf. Explains the theory and practice of lead refining by the Betts process, describing a plant and the process of testing the slimes, and all by-products. 1300 w. Min Rept—May 9, 1907. Serial. 1st part. No. 84304.

Electroplating.

Recovering Silver from Cyanide Solutions. Describes the recovery by precipitation and by evaporation, stating the dangers of the first, and illustrating an evaporating furnace. 1000 w. Brass Wld—May, 1907. No. 84453.

ELECTRO PHYSICS.

Batteries.

An Electrical Method of Depolarizing Primary Batteries. Frank W. Springer. Describes an invention relating to the improvement of systems for the supply of current in which primary cells or batteries are employed, especially the improvement of ignition systems of explosive engines. 2000 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84629 N.

Dielectrics.

On the Loss of Energy in Dielectric Substances in Condensers and Cables (Ueber den Energieverlust im Dielektrikum von Kondensatoren und Kabeln). Bruno Monasch. Methods and results of experimental determination for various substances. Ills. 9500 w. Serial. 2 parts. Elektrotech u Maschinenbau—April 21 and 28, 1907. No. 84156 each D.

Lightning.

New Principles in the Design of Lightning Arresters. E. E. F. Creighton. The first of two papers discussing the new features of a new multigap arrester. Ills. 4000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84510 D.

Protection Against Lightning, and the Multigap Lightning Arrester. David B. Rushmore and D. Dubois. On the most recent developments in the multigap lightning arrester, giving recommendations concerning the protection of transmission lines and electrical apparatus from lightning disturbances. Ills. 7000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84509 D.

GENERATING STATIONS.

Central Plants.

Recent Developments in Large Central Electric Plants. Thomas C. McBride. A review of progress dealing only with the more important details, especially with those that aim at lessening the cost of production and distribution. General discussion. 11000 w. Pro Engrs' Club of Phila—April, 1907. No. 84523 D.

Commutation.

Problems in Commutation. Miles Walker. Discusses some of the causes of bad commutation. 3500 w. Elec Jour—May, 1907. No. 84477.

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Direct-Current.

Parallel Operation of Direct-Current Generators. J. C. Hail. Considers shunt-wound generators connected in parallel, and compound wound generators in parallel operation. Diagrams. 2000 w. Elec Age—May, 1907. No. 84622 C.

Exciters.

Exciter Troubles. A. E. Buchenberg. Diagram and general discussion of the difficulties and troubles which may arise in the operation of direct-current machines when used as exciters for alternators. 3000 w. Elec Wld—May 4, 1907. No. 84206.

Germany.

Statistics of Electric Power Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). Gives the essential details of over 1,600 electric power plants, either in operation or under construction, location, purpose, motive power, machines, capacity, etc. 75000 w. Elektrotech Zeitschr—April 18, 1907. No. 84173 D.

Hydro-Electric.

Notes on Hydro-electric Plant Organization and Operation. Farley Osgood. Discusses the hydraulic power-station, and line departments and the organization of the personnel of an operating system. 8500 w. Pro Am Inst of Elec Engrs —April, 1907. No. 84512 D.

Power Development on the Kootenay River for the West Kootenay Power & Light Company, Limited. Robert A. Ross and Henry Holgate. Illustrated description of a power development at Upper Bonnington Falls, British Columbia. 3500 w. Can Soc of Civ Engrs—May 9, 1907. No. 84396 N.

The Huronian Company's Power Development. Robert A. Ross and Henry Holgate. Illustrated description of the development at High Falls, on the Spanish River, to furnish power for the nickel and copper mines of the Sudbury District. 6000 w. Can Soc of Civ Engrs —April 25, 1907. No. 84395 N.

The Great Falls Station of the Southern Power Co. Curtis A. Mees and John H. Roddey. Part I gives an illustrated description of the natural power and the hydraulic features of the development. 5000 w. Eng Rec—May 18, 1907. Serial. 1st part. No. 84425.

The St. Croix Falls Power Plant. Wadsworth A. Williams. Illustrated description of the water-power development on the St. Croix River, which transmits current for power and light to Minneapolis, 40 miles distant. 1800 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84633 N.

Tyrol Hydro-Electric Power Station, Keiserwerke. Illustrates and describes an installation for supplying power for industrial and lighting purposes in the northern part of Tyrol. 1700 w. Elec Wld—May 11, 1907. No. 84310.

The Cazadero Generating Station of the Portland Railway Light & Power Company. An illustrated description of an interesting installation in Oregon, comprising a dam across the Clackamas river, a flume and waterway 1.7 miles long, the generating station and a step-up transformer station. 1100 w. Elec Ry Rev—May 11, 1907. No. 84279.

Water-Power Development at Kardaun near Bozen (Wasserkraftanlage Kardaun bei Bozen). Andreas Stamm. Illustrated detailed description of dam, pipe-line, power house, turbines, generators, etc., at this plant in the Tyrol. 3000 w. Serial. 2 parts. Zeitschr f d Gesamte Turbinenwesen—April 10 and 20, 1907. No. 84157 each D.

The Pöls Power Plant (Die Pölswerke). Philipp Ehrlich. Illustrated description of an Austrian hydro-electric power plant generating 1,100 horse power. 2000 w. Zeitschr d Oest Ing u Arch Ver —April 26, 1907. No. 84180 D.

Lightning Arresters.

See Electrical Engineering, Electro-Physics.

Operation.

Suggestions for the Power House Operator. Arthur B. Weeks. Remarks on the importance of self-control in emergencies, and of originality and thorough understanding of the apparatus. 1000 w. Elec Wld—May 4, 1907. No. 84210.

Power Stations.

The New Turbine Power Station of the Dallas Electric Corporation. Illustrated detailed description. 2500 w. St Ry Jour—May 18, 1907. No. 84371.

The Kent Electric Power Company. Illustrates and describes the generating plant of this company, at Frindsbury. 1500 w. Elect'n, Lond—May, 1907. Serial. 1st part. No. 84438 A.

A Most Economical System for Generation of Current. Illustrates and describes a reconstructed station at Lockport, N. Y., where a system of underground steam heating is installed, which utilizes all the heat in exhaust steam and most of that in the flue gases. 2200 w. Engr, U S A—May 15, 1907. No. 84404 C.

Regulation.

Balancers. William H. Taylor. Gives diagrams showing the arrangements of connections for balancers, and discussing their defects. 700 w. Elec Rev, Lond—May 10, 1907. No. 84437 A.

Rome.

Progress on Rome's Municipal Electric Plant (Progretto per l'Impianto Elettrico Comunali di Roma). G. Giorgi. A description of the plant with plates showing

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the construction of the buildings, the arrangement of machines, etc. 9000 w. Boll della Soc d Ing e d Arch Ital—April 15, 1907. No. 84123 F.

The Municipal Electrical Installation of Rome. Trans. from *L'Ing. Ferroviaria.* Particulars in regard to a proposed municipal electrical undertaking for lighting and power at Rome, Italy. Ills. 1200 w. Elec Rev, Lond—May 17, 1907. No. 84575 A.

Wind Power.

Wind Power for the Generation of Electricity. W. O. Horsnaill. Considers the possibility of utilizing wind power for the electric lighting of country houses and gives an account of actual installations. 2000 w. Elect'n, Lond—May 3, 1907. Serial. 1st part. No. 84337 A.

LIGHTING.

Costs.

A Comparative Study of Lighting Costs and Related Matters (Vergleichende Betrachtungen über Beleuchtungskosten und Einschlägiges). August Marussig. The first instalment of the serial gives the mathematics of illumination and discusses the lighting power of various illuminants. Diagrams. 5000 w. Serial. 1st part. Oest Wochenschr f d Oeff Baudienst—April 13, 1907. No. 84178 D.

Frosted Lamps.

A Brief Theory of the Reduction in the Service Life of Frosted Incandescent Lamps. Dr. A. E. Kennelly. Outlines a quantitative theory deriving formulæ which serve to explain the results obtained by Preston S. Millar. 1600 w. Elec Wld—May 18, 1907. No. 84416.

Incandescent Lamps.

Economic Considerations in the Use of Metallic-Filament Incandescent Lamps (Considerazioni Economiche sull' Uso di Lampade Incandescenti a Filamento Metallico). D. Civita. Mathematical and descriptive paper. 3000 w. Elettricitá—April 12, 1907. No. 84120 D.

On the Temperature and Illuminating Properties of Carbon, Osmium and Tungsten (Ueber Temperatur und Lichtemission von Kohle, Osmium und Wolfram). A. Grau. Results and comparison of tests of lamps with filaments of these substances. Ills. 2000 w. Elektrotech u Maschinenbau — April 14, 1907. No. 84155 D.

A New Leading-in Conductor for Electric Lamps. C. O. Bastian. Read before the Glasgow Sec. of the Inst. of Elec. Engrs. Describes the Sineplat seal, which consists of enamel glass on copper wire. 1700 w. Elec Engr, Lond—May 17, 1907. No. 84574 A.

Moore Light.

Light from Gaseous Conductors Within Glass Tubes—The Moore Light. D. McFarlan Moore. An illustrated article explaining and describing this system, and reporting comparative tests. 9500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84519 D.

MEASUREMENT.

Candle Power.

The Determination of the Mean Horizontal Candle-Power of Glow Lamps. F. Uppenborn. Abstract trans. from *Elektrotech. Zeitschr.* Describes the four chief methods, investigating the conditions necessary to obtain accurate results. 2500 w. Elect'n, Lond—May 3, 1907. No. 84338 A.

Conductors.

Potential Stresses as Affected by Overhead Grounded Conductors. R. P. Jackson. Introduction to a discussion. A theoretical investigation of the potential gradients and the equipotential surfaces about grounded conductors suspended in the air, and about metallic towers for transmission lines. 1500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84517 D.

Galvanometer.

A New Galvanometer. J. K. A. W. Salomonson. Trans. from *Physikalische Zeitschrift.* A description of the instrument, explaining its uses and stating its advantages. 1600 w. Elect'n, Lond—April 26, 1907. No. 84249 A.

Speed-time Curves.

The Plotting of Speed-time Curves. A. S. Langsdorf. Gives a method, based on rigid laws of the calculus, requiring no approximations, and giving results quickly. 300 w. Elec Wld—May 18, 1907. No. 84417.

Synchroscope.

The Synchroscope. D. H. Cohen. A description of the construction, and more particularly the operation, of this instrument. 800 w. Elec Wld—May 4, 1907. No. 84209.

Thermo-Couple.

Commercial Temperature Measurements with the Thermo-Electric Couple. Anthony Zeleny. Describes apparatus for the accurate measurement of ordinary temperatures by the direct deflections method, considering the problems in connection with the development of pyrometry. Ills. 3500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84627 N.

Voltage.

Voltmeter Compensator for Direct-Current Circuits. F. E. Haskell. Describes a scheme employed with direct-current equipment which enables the station voltmeter to indicate the e.m.f. at the distribution point. 800 w. Elec Wld—May 25, 1907. No. 84609.

Wheatstone Bridge.

Notes on the Calibration of a Wheatstone Box Bridge. B. E. Smith. Out-

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lines a scheme worked out for the purpose of calibrating a box bridge which was to be used in investigating the electromotive forces developed in thermo-electric couples by small differences of temperature. 1500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84634 N.

The Wheatstone Bridge. Dana Pierce. Describes the connections and arrangement and use for measuring resistance, explaining the principle it involves. 1600 w. Engr, U S A—May 15, 1907. No. 84409 C.

TRANSMISSION.

High Tension.

Relays for the Control of High-Tension Switchgear. Charles C. Garrard. Discusses points which have proved of importance in experience with the apparatus used in the control of automatic switchgear on high-tension systems. 3500 w. Elec Engr, Lond—April 26, 1907. No. 84245 A.

Lightning.

Lightning Phenomena in Electric Circuits. J. C. Peebles. A discussion of the effects of lightning upon electric conductors, confined mostly to large power transmission lines. 3000 w. Sib Jour of Engng—May, 1907. No. 84558 C.

Line Towers.

Reinforced-Concrete Towers for High-Potential Transmission Line. F. W. Scheidenhelm. Illustrated detailed description of two recently completed reinforced-concrete towers, at Brownsville, Pa., for supporting a line across the Monongahela River. 2800 w. Eng News—May 2, 1907. No. 84041.

Poles.

The Use of Wooden Poles for Overhead Power Transmission. C. Wade. Illustrated report of tests made of A poles and of single poles, with appendix by Prof. Goodman. 6500 w. Inst of Elec Engrs—May 2, 1907. No. 84479 N.

Self Induction.

Oscillations of High Pressure and Frequency in Continuous-Current Circuits (Ueber Schwingungen mit hoher Spannung und Frequenz in Gleichstrom-Netzen). Dr. R. Hiecke. Mathematical discussion of an article with the same title by Herrn Feldmann and Herzog, Sept., 1906. Diagrams. 3300 w. Elektrotech Zeitschr—April 11, 1907. No. 84171 D.

MISCELLANY.

Agriculture.

Electricity in Agriculture (L'Elettricità nell' Agricoltura). Emilio Guarini. Discusses the various ways in which electricity could be used to advantage in agriculture. 3300 w. Serial. 1st part. Elettricità—April 19, 1907. No. 84121 D.

Depreciation.

Depreciation. Robert Hammond. Introduces this question aiming to arouse a discussion and reach a conclusion as to the proper provision which should be made in electrical undertakings. 5000 w. Inst of Elec Engrs—April 25, 1907. No. 84248 N.

Depreciation. Editorial review of recent papers on this subject. Especially the papers of Robert Hammond, P. D. Leake, and Lawrence R. Dicksee. 2800 w. Engng—May 3, 1907. No. 84343 A.

Electrical Engineering.

The Coming of Age of Electrical Engineering. B. A. Behrend. A review of the past development, with some suggestions as to the future outlook. Ills. 2000 w. Cassier's Mag—May, 1907. No. 84051 B.

Granary Equipment.

The Electrical Equipment of a Buenos Ayres Granary. Illustrated description of an electrical installation of somewhat unusual interest. 1000 w. Elec Rev, Lond—April 12, 1907. No. 83871 A.

Print Works.

Electric Motor Driving for Print Works (Der elektrische Antrieb in Zeugdruckereien). Max Arbeiter. Description of results obtained by use of motors in cotton print works. Illus. 2000 w. Elektrotechnische Zeitschrift—March 21, 1907. No. 83649 B.

Radioactivity.

Radioactivity and Atmospheric Electricity. Prof. H. Geitel. Trans. from Umschau. A report of experimental investigations which appear to support the theory that the phenomena of atmospheric electricity can be derived from the observed radioactivity of the soil and ionization of the air. Ills. 2500 w. Sci Am Sup—April 27, 1907. No. 83914.

Rates.

Rates of Charge for Electricity and Their Effect on Cost. J. S. Codman. Read before the Boston and Cornell Branches of the Am. Inst. of Elec. Engrs. Describes the load-factor system and the modifications which represent the best present practice; also methods of determining the customer's maximum demand and consumption. 8500 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84508 D.

Selenium.

Use of Selenium in Photometric Measurements (Die Anwendung des Selens zu photometrischen Messunger). Paul von Schrott. Review of what has been accomplished in the study of the properties of selenium. 2000 w. Elektrotechnische Zeischrift—March 28, 1907. No. 83651 B.

Tariffs.

Tariffs from Electric Motive Power. A. C. Hanson. An examination of some

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of the methods of charging for electrical energy used for motive power purposes. 1800 w. Elec Rev, Lond—April 26, 1907. No. 84247 A.

Modern Methods of Selling Electrical Energy (Tarifications Modernes). Gaston Rosenwald. Discusses the various systems used by Central Stations and describes the leading types of meters employed. Ill. 7500 w. Soc Belge d Elec'ns—April, 1907. No. 84101 F.

Units.

Electric Units (Conferencia sobre Unidades Eléctricas). D. J. M. de Madariaga. Read before the Instituto de Ingenieros Civiles. Mathematical discussion. 1500 w. Serial. 1st part. La Energia Eléctrica—April 10, 1907. No. 84124 E.

INDUSTRIAL ECONOMY

Competition.

"Made in Germany": A Study of Competition. Louis Bell. Discusses the methods of American business as related to foreign competition, stating facts and suggesting remedies. 2500 w. Engineering Magazine—June, 1907. No. 84191 B.

American Competition (La Concurrence Américaine). M. Vialate. The first instalment deals with industrial organization, conditions of labor, industrial legislation, labor unions, etc. Serial. 1st part. 16000 w. Bull Soc d'Encour—March, 1907. No. 84108 G.

Depreciation.

See Electrical Engineering, Miscellany.

Education.

The Education of Mining and Metallurgical Engineers. John Bonsall Porter. Outlines a course of study desirable and gives a report of the work in mining and metallurgy at McGill University. Discussion. Ills. 10000 w. Jour Can Min Inst—1906. No. 83812 N.

The Teaching of Metallurgy in College Laboratories, with a Description of the Metallurgical Laboratories of McGill University. A. Stansfield. A synopsis of the teaching at McGill, with a brief discussion of general principles. Ills. 4200 w. Jour Can Min Inst—1906. No. 83813 N.

Commercial Value of Industrial Schools. Samuel F. Hubbard. Discussion of methods for establishing and managing trade schools that shall be a practical aid in the manufacturing industries. 2500 w. Am Mach—Vol. 30. No. 14. No. 83441.

The Carnegie Technical Schools, Pittsburg, Pa. Day Allen Willey. Information of interest in regard to these schools, with illustrations. 1600 w. Sci Am—April 13, 1907. No. 83578.

Technical Training of Electrical Artisans. C. P. C. Cummins. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Discusses present methods of training and their defects, and outlines a revised system. 6000 w. Elec Engr, Lond—April 19, 1907. No. 83990 A.

A Railroad University. Altoona and Its Methods. Frederic Blount Warren. An illustrated description of the system employed by the Pennsylvania Railroad for the practical training of technical students. 2500 w. Engineering Magazine—May, 1907. No. 83935 B.

The Technical Student and the Engineering Apprenticeship Course. H. Cole Estep. A statement of the present attitude of technical students toward the engineering-apprenticeship courses offered by United States manufacturers. 2000 w. Engineering Magazine—May, 1907. No. 83934 B.

Engineering Business.

Starting an Engineering Business. Sydney F. Walker. An examination of present conditions and the essentials to secure success. 1200 w. Prac Engr—May 17, 1907. Serial. 1st part. No. 84607 A.

Expositions.

The Exposition of the French Physical Society in 1907 (L'Exposition de la Société de Physique en 1907). M. Aliamet. The first instalment deals with the electrical exhibits, accumulators, condensers, lamps, clocks and measuring instruments. Ill. Serial. 1st part. 2500 w. L'Elec'n—April 27, 1907. No. 84107 D.

Types of Machines, Electrical Devices, and Automobiles at the Milan Exposition (Allgemeiner Maschinenbau, Elektrische Einrichtungen und Automobilwesen auf der Ausstellung in Mailand). Herr Pflug. The first instalment describes gas engines, ships coaling devices and the tractor of the Freibahn road train. Ills. 6000 w. Serial. 1st part. Glaser's Annalen—April 15, 1907. No. 84137 D.

Filing System.

Filing System for Technical Information. Oscar E. Perrigo. Illustrated description of a cabinet provided with filing drawers for clippings, storage space for periodicals and a card-index system. 2000 w. Am Mach—Vol. 30, No. 19. No. 84300.

Glasgow.

Industrial Developments in Glasgow.

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An account of the extensive industrial migration to the outskirts of the city. Ills. 2200 w. Engng—May 3, 1907. No. 84341 A.

Industrial Betterment.

The Square Deal to the Railroad Employee. H. W. Jacobs. An illustrated account of the extensive work carried out by the A., T., & S. F. Ry. for the benefit of employees. The construction and maintenance of reading rooms, recreation halls, hospitals; improvement of shops and yards; establishing pensions, etc. 2000 w. Engineering Magazine—June, 1907. No. 84192 B.

Inventions.

The Pursuit of Inventing as a Business. George F. Stratton. Gives brief outlines of the methods of work of some successful inventors, and discusses the modern tendency to keep the inventor inventing, and place the exploitation of his inventions in the hands of business managers. 2000 w. Engineering Magazine—June, 1907. No. 84196 B.

The Utility of Inventions. John E. Brady. Explains the meaning of utility as predicated of inventions and why some inventions are not patentable, giving examples of actual cases. 1800 w. Elec Wld—June 1, 1907. No. 84725.

Iron Ore.

The North Swedish Iron-Ore Deposits. Editorial on the recent legislative action by which the Swedish State becomes the proprietor of half the share capital in the company owning the ore deposits which do not already belong to the State. 1700 w. Engng—April 26, 1907. No. 84255 A.

Iron Trade.

Presidential Address. Sir Hugh Bell. A review of the iron trade during the last 100 years. Also an appendix giving a chronological table of some of the more important events connected with iron and steel, during the time covered. 5000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84611 A.

Labor.

A Decision on Rates of Pay for Steam Shovel Men and Engine Runners on the Panama Canal Work. A statement concerning the present rates of pay for the classes of labor named. 1700 w. Eng News—May 9, 1907. No. 84298.

The Labor Problem of the Panama Canal. A. Beeby Thompson. An account of the extensive work accomplished in the solving of the housing, feeding, and health problems, with a discussion of the labor supply. 2800 w. Engng—May 3, 1907. No. 84344 A.

White Labor Situation on the Rand. G. A. Denny. An explanation of present conditions, especially the attitude of the rock-drill miners. 2200 w. Min Jour—May 11, 1907. No. 84440 A.

The Eight-Hour Day in French Government Works. Editorial, outlining the experiments with the eight-hour day made in the French State establishments, which show that reduction in hours of labor cause a reduction in output and a large increase in cost. 2000 w. Engng—May 10, 1907. No. 84636 A.

An Industrial Agreement. Gives the text of the agreement between the Employers' Federation and three unions, which has been provisionally signed by the representatives of both sides, and is awaiting the ratification of the constituents. Also editorial. 2500 w. Engr, Lond—May 3, 1907. No. 84351 A.

Labor Insurance.

Insurance of Labor in Germany. Information in regard to the system, and the laws of Germany which provide against accidents, and for sickness, incapacity and old age; and also the provision made by private companies. 4000 w. Engng—April 19, 1907. No. 84004 A.

Management.

Profit Making in Shop and Factory Management. C. U. Carpenter. This fifth article of a series considers the operation of the machine tools, and conditions necessary for manufacturing at minimum cost. 6000 w. Engineering Magazine—June, 1907. No. 84194 B.

Municipal Ownership.

How Chicago is Solving Municipal Ownership of Transportation Facilities. C. Frederick Collins. Explains the present condition of transportation facilities in Chicago, and the ordinances recently passed which gives the city 55 per cent. of the net profits, and yet leaves the operation of the lines under the management of practical street railway men. 1500 w. Sci Am—May 25, 1907. No. 84544.

Municipal Ownership in England. R. S. Hale. A general discussion of the subject, and of the operation of gas and water works. 4500 w. Cassier's Mag—May, 1907. Serial. 1st part. No. 84047 B.

New South Wales.

The Mineral Industry of New South Wales. F. S. Mance. The output for 1906 shows an increase in value of £1,083,000 as compared with the production of 1905. 2000 w. Eng & Min Jour—May 11, 1907. No. 84315.

Storekeeping.

Storekeeping at the Navy Yards. John A. Mudd. A discussion of the difference between storekeeping under the Naval Supply Fund and that under the Bureau Appropriations, showing the economy and advantages of the former, and related subjects. 18500 w. Pro U S Nav Inst—March, 1907. No. 84023 F.

We supply copies of these articles. See page 687.

MARINE AND NAVAL ENGINEERING

Battleships.

The Size of Battleships as a Function of Their Speed. M. J. A. Normand. Trans. from *Bul. de L'Assn. Tech. Maritime.* Aims to give an approximate solution of the problem of determining how the size of fighting ships varies with their speed, when their offensive and defensive powers, as well as their radius of action, remain unchanged. Also comments by D. W. Taylor. 3500 w. Pro U S Nav Inst —March, 1907. No. 84024 F.

Bruges.

The Harbor and Ship Canal of Bruges (Die Häfen und der Seekanal von Brügge). Abstract of a paper by M. L. Coiseau describing the harbor-improvement projects outlined in 1891 and the progress made. Ills. 35000 w. Oest Wochenschr f d Oeff Baudienst—April 6, 1907. No. 84177 D.

Combustion Motors.

Internal-Combustion Engines and Their Application to War Ships (Die Verbrennungskraftmaschine und ihre Verwendung auf Kriegsschiffen). Emil Capitaine. Abstract of a paper in the "Schiffbautechnischen Gesellschaft." Ills. 3000 w. Elektrotech u Polytech Rundschau—April 4, 1907. No. 84168 D.

Crane.

A 150 Ton Hydraulic Crane (Grue Hydraulique de 150 Tonnes). F. Hofer. A description of a large crane recently installed at the Elswick dockyards, Newcastle-on-Tyne, England, illustrated by a detailed plate of the operating mechanism. Ills. 1800 w. Génie Civil—April 13, 1907. No. 84112 D.

Danger Signals.

Kilroy's System of Danger Signals for Warship-Turrets. A means of giving warning to the man in charge of a gun whenever his gun is so trained that by firing it might injure another gun is illustrated and described. It has been adopted by the British navy. 1500 w. Engng—May 10, 1907. No. 84444 A.

Dry-Docks.

Elderslie Graving-Dock. William Park Weir. Cross-sections and description of the construction of this dock on the River Clyde. 1200 w. Inst of Civ Engrs —No. 3639. No. 84464 N.

The Tredegar Dry Dock, Newport, Monmouth. Sigismund Alfred Frech. Illustrated description of the construction, and the methods adopted to overcome the difficulties encountered. 5000 w. Inst of Civ Engrs—No. 3646. No. 84463 N.

Fleet Telephony.

See Electrical Engineering, Communication.

Fog.

The Artificial Dispersion of Fog (De la Dispersion Artificielle du Brouillard). M. Dibos. Discusses the nature and causes of fog and describes the researches of the author on its artificial dispersion, his apparatus, results, etc. Ill. 5000 w. Mem d l Soc d Ing Civ d France—March, 1907. No. 84105 G.

Lighthouse.

Cape Race Lighthouse. Illustrates and describes a new tower of reinforced concrete, cylindrical in form, and higher than the existing structure, about to be erected on the coast of Newfoundland; also the optical apparatus which is of the highest power. 2000 w. Engr, Lond—May 3, 1907. No. 84345 A.

Liner.

The New White Star Liner "Adriatic." Illustrations, with description of this fine vessel, the largest at present afloat. 1200 w. Sci Am—May 25, 1907. No. 84545.

Motor Boats.

The Fourth Annual Motor Boat Exhibition and Races at Monaco. An account of these races with illustrations of some of the fast and novel boats. 2000 w. Sci Am Sup—May 11, 1907. No. 84328.

Motor-Boat Propellers. G. R. McDermott. Presents formulæ for use in the motor-boat field, with explanatory notes. 1800 w. Sib Jour of Engng—May, 1907. No. 84557 C.

Propulsion.

Screw Propellers. T. Sidney Cockrill. Read before the Liverpool Engng. Soc. Considers the general features of screw propulsion and propeller design. 6500 w. Marine Rev—May 2, 1907. No. 84089.

Resistance.

The Resistance of Ships. A. W. Johns. Read before the Inst. of Naval Archts. Considers some of the approximate formulæ for determining the resistance of ships, showing comparisons of the results given by them and those obtained by experiments on models. 3000 w. Engng —April 26, 1907. No. 84257 A.

Shipbuilding.

Newport News Great Shipbuilding Plant. William H. Stone. Information concerning the desirable location and excellent equipment of this plant. Ills. 2000 w. Mfrs' Rec—May 9, 1907. No. 84262.

We supply copies of these articles. See page 687.

Shipyards.

Visits to European Navy Yards and Shipyards During the Summer of 1906. Cecil H. Peabody. Describes visits to six navy yards and thirteen private yards, giving plans. 12000 w. Tech Qr—March, 1907. No. 84471 E.

Steamers.

Passenger Steamers for the Cuyaba River, Brazil. Illustrates and describes vessels designed for the exceptionally shallow draught of 18 in. with steam up and bunkers half full. 800 w. Engng—May 10, 1907. No. 84446 A.

Steam Navigation.

Early History of Steam Navigation. An illustrated article reviewing the early history of navigation, especially since the application of steam to the propulsion of vessels. 3500 w. Rudder—May, 1907. Serial. 1st part. No. 84263 C.

Submarines.

The Construction and Handling of Submarines. Walter Bernard. Illustrates and describes the Holland, and the Lake types of submarines under competitive trials at Newport. 1400 w. Sci Am—May 18, 1907. No. 84390.

Tide Signaling.

The Boyd Automatic Tide Signaling Apparatus. Illustrates and describes an apparatus installed at Irvine, Scotland, to inform incoming captains of the state of the tide, as vessels can enter only at high tide. The invention of Martin Boyd. 900 w. Sci Am Sup—May 25, 1907. No. 84549.

Torpedo Boats.

Torpedo Vedette-Boats for the Roumanian Government. Illustrated detailed description of a screw torpedo vedette-boat and its equipment. 1400 w. Engng—April 19, 1907. No. 84003 A.

Vibration.

Vibrations in Recent Steamships (Vibrationserscheinungen neuerer Schnelldampfer). W. Thele. A discussion of vibration diagrams taken by the writer on the "Kaiserin Auguste Victoria," "Amerika," and "Deutschland," the first part of the serial giving a mathematical treatment of the laws of vibration. Ills. 3300 w. Serial. 1st part. Schiffbau—April 24, 1907. No. 84133 D.

MECHANICAL ENGINEERING

AUTOMOBILES.

Acetylene.

Dissolved Acetylene. Explains the advantages of this product for use in lighting motor cars, illustrating the mechanical details of the apparatus employed. 2500 w. Auto Jour—April 27, 1907. No. 84239 A.

Air-Cooling.

Air-Cooling of Automobile Engines. John Wilkinson. Explains the science of air-cooling in regard to the internal conditions of the cylinder, and discusses the external conditions. 1800 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84638 F.

Alcohol.

Alcohol as a Fuel for the Automobile Motor. Thomas L. White. Read before the Soc. of Auto. Engrs. Reviews the considerations to be dealt with in using alcohol as a fuel, discussing the carburation problem, and proposing a solution by means of a mixture of acetylene, alcohol vapor and air. 2200 w. Automobile—May 2, 1907. No. 84068.

Brakes.

Brakes and Their Care and Repair. Victor Longheed. Considers the importance of maintaining brakes in proper condition, pointing out the essentials of such maintenance and condition. 2000 w. Automobile—May 2, 1907. No. 84069.

Construction.

Some Features of Automobile Construction. Thomas J. Fay. Read before the Soc. of Auto. Engrs. Discussion of materials and points in construction. 2000 w. Automobile—May 23, 1907. Serial. 1st part. No. 84537.

De la Buire.

The 24 H.P. De la Buire Car. Illustrates and describes features of interest in the design and construction of these French cars. 2000 w. Autocar—May 11, 1907. No. 84435 A.

Electric.

Electrically-Driven Motorcars at the Berlin Automobile Show in 1906 (Elektrisch betriebene Motorwagen auf der Automobilausstellung in Berlin 1906). K. Meyer. Illustrated description of various types. 9000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 13, 1907. No. 84143 D.

Enfield.

Some Details of the Enfield Cars. Illustrations and particulars in regard to interesting details of these cars. The engine, steering gears, front axle, and the 25 h.p. change-speed gear. 900 w. Autocar—April 27, 1907. No. 84241 A.

Fire-Engine.

Motor Steam Fire-Engine for Johannesburg. Illustrated description. Liquid fuel is used. 700 w. Engng—April 26, 1907. No. 84254 A.

We supply copies of these articles. See page 687.

Gear Box.

Tests of a Speed-Change Gear Box. Richard C. Williams. Describes tests which showed the efficiency of an automobile transmission box to decrease with increase of the speed ratio and to fall off markedly in reverse gear. Ills. 2000 w. Am Mach—Vol. 30, No. 19. No. 84303.

Gears.

Gear Changing. Marcus W. Bourdon. Gives explanations of the various changing movements and suggestions for a noiseless method of changing. 2000 w. Autocar—April 27, 1907. No. 84242 A.

The Fairfax Epicyclic Gear. Explains the epicyclic principle of change-speed gears, and gives an illustrated description of the type. 1500 w. Auto Jour—April 27, 1907. No. 84240 A.

Ignition.

Concerning the Use of the Dry Cell. Arthur P. Jackson. Considers that dry cells, intelligently used, furnish the best ignition. Discusses why they give out quickly and other troubles. 1200 w. Automobile—May 23, 1907. No. 84538.

Motor Omnibuses.

The Management of the Motor Omnibus Company of St. Blaise (Der Betrieb der Motorwagen-Gesellschaft St. Blasen). Herr Pflug. Describes the cars, tariffs and management of a motor omnibus line operating over a difficult line in Switzerland, giving costs. Ills. 2500 w. Zeitschr d Mit Motorwagen Ver—March 31, 1907. No. 84165 D.

Petrol Electric.

The British Thomson-Houston Petrol-Electric System. Illustrates and describes the "simple electric" system adopted by this firm; the present article considers the mechanical features. 1800 w. Auto Jour—May 11, 1907. Serial. 1st part. No. 84434 A.

Petrol Tractors. J. F. Gairns. An illustrated account of the best English practice in the use of gasoline automobile traction. 2500 w. Cassier's Mag—May, 1907. No. 84055 B.

Pilgrim.

The 25-30 H.P. Pilgrim Car. An illustrated description of a British-made car driven by a horizontal engine. 2000 w. Autocar—April 27, 1907. No. 84243 A.

Porthos.

The Porthos Petrol Car. An illustrated description of a car of novel design, having a stationary live-axle enclosed in a rotating tube. 1400 w. Auto Jour—April 27, 1907. Serial. 1st part. No. 84238 A.

Problems.

I. The Automobile. Frederick L. Garlinghouse. II. Automobile Transmission. E. H. Belden. III. Automobile Tires. H. W. Du Puy. Three short papers discussed together. Also short paper on Internal Combustion Engines, by William R. Flint. Ills. 12000 w. Pro Engrs' Soc of W Penn—April, 1907. No. 84026 D.

Road Trains.

The Freibahn Train Automobile (Train Automobile de la Société Freibahn). A. Bidault des Chaumes. Illustrated description of a heavy steam traction engine for hauling heavy loads on highways. 2000 w. Génie Civil—April 27, 1907. No. 84117 D.

Wheels.

Spring Wheels (Federnde Räder). Herr Ruthemeyer-Friedenau. Illustrated detailed description of various types. 2000 w. Zeitschr d Mit Motorwagen Ver—April 15, 1907. No. 84166 D.

COMBUSTION MOTORS.

Alcohol.

The Manufacture, Denaturing, and the Technical and Chemical Utilization of Alcohol. M. Klar. The present number considers the distillation of alcohol, its production from starch, yield of wash and of volatile by-products. 2000 w. Sci Am Sup—May 11, 1907. Serial. 1st part. No. 84332.

Alcohol Engines to Replace Gasoline Engines. John Preston. Remarks on some of the advantages of denatured alcohol and some of the differences between the behavior of an engine when running on gasoline and its action with alcohol. 1000 w. Sci Am—May 11, 1907. No. 84327.

Design.

The Design of Modern Producers and Gas Engines. R. E. Mathot. Presents in the present article the general principles of construction considered as the best practice. 3000 w. Engineering Magazine—June, 1907. No. 84198 B.

Efficiency.

Effect of Size on the Thermal Efficiency of Explosion Motors. H. L. Callendar. Discusses losses of heat to the cooler walls of the cylinder during ignition and expansion. 3500 w. Mech Engr—May 18, 1907. Serial. 1st part. No. 84623 A.

Fuels.

Liquid Fuels and Their Utilization in Combustion Engines, with Special Reference to the Diesel Motor (Die flüssigen Brennstoffe und ihre Ausnutzung in der Verbrennungskraftmaschine, mit besonderer Berücksichtigung des Dieselmotors). Karl Kutzbach. Comparison of the relative values of various fuels. Ills. 7800 w. Serial. 2 parts. Zeitschr d Ver Deutscher Ing—April 6 and 13, 1907. No. 84140 D

Investigations on the Application of Tar Oils in the Operation of Diesel Motors (Versuche über die Verwendung von Teerölen zum Betrieb des Dieselmotors).

We supply copies of these articles. See page 687.

Paul Rieppel. Investigations on the values of various oils as fuels for internal-combustion motors, with special reference to tar oils. Curves and Diagrams. 5500 w. Zeitschr d Ver Deutscher Ing—April 20, 1907. No. 84145 D.

Gas Engines.

Producer Gas Engines. G. W. Bissell. Abstract of a paper read before the Iowa Elec. Assn. A report and comparison of tests made. 800 w. Elec Ry Rev—May 11, 1907. No. 84280.

The Two vs. the Four-Stroke Cycle Gas Engine. Louis Illmer, Jr. A discussion favoring the two-stroke cycle engine and recommending independent air and gas pumps. 3500 w. Engr, U S A—May 15, 1907. No. 84408 C.

Gasolene Engines.

Offset Cylinders in Gasoline Engines. E. J. Bartlett. A technical discussion of the conditions and the method of evening the pressure by offsetting the center of the cylinder from that of the crank-shaft so that the angle of the connecting-rod is unequal during the two strokes. 1500 w. Am Mach—Vol. 30, No. 20. No. 84376.

Gas Producers.

Steam in Gas Producer Practice. William Arthur Bone. Read before the Ir. & St. Inst. A record of experiments made to determine the influence of variation in the proportions of air and steam in the blast upon the composition of the blast, its suitability for furnace operations, and upon the thermal efficiencies of the producers. 7500 w. Engng—May 17, 1907. No. 84581 A.

Equations and Diagrams of the Operations in the Gas Producer (Gleichungen und Diagramme zu den Vorgängen im Gasgenerator). R. Mollier. Mathematical and graphical representations of the operation and products of a gas producer under various working conditions of air and water supply. Diagrams. 3600 w. Zeitschr d Ver Deutscher Ing—April 6, 1907. No. 84141 D.

Gas Turbines.

The Gas Turbine (Le Turbine a Gas). Giuseppe Belluzzo. A general review of theory and practice. Ills. 1500 w. Serial. 1st part. L'Industria—April 28, 1907. No. 84122 D.

On the Problems of the Gas Turbine (Zur Frage der Gasturbine). Felix Langen. A practical discussion of various points in gas turbine operation. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 10, 1907. No. 84-158 D.

Water Gas.

Water Gas (Das Wassergas). Herr Kayser. Discusses the use of water gas for lighting, heating and power purposes, describes its generation and gives tables of costs of actual plants, notably the municipal plant at Berlin. Ills. 6000 w. Gesundheits Ing—April 6, 1907. No. 84182 D.

HEATING AND COOLING.

Car Sheds.

Heating Large Car Inspection Sheds. The heating of the sheds of the Brooklyn Rapid Transit Co. is described, also the down-draft forge installation. 2200 w. Eng Rec—May 18, 1907. No. 84429.

Fans.

Centrifugal Electric Driven Fans. John Howatt. Considers fans for producing artificial ventilation. 2300 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84631 N.

Furnaces.

Megass Furnaces. Richard Lloyd. Describes some trials of ordinary megass furnaces, as used in British Guiana, with special reference to the quantity of air admitted for combustion. Ills. 2200 w. Inst of Civ Engrs, No. 3643—No. 84462 N.

Heat Absorption.

Heat Absorption Through Tubes. William R. Billings. Considers the effect of using water in small streams at high velocity. Ills. 2000 w. Engr, U S A—May 15, 1907. No. 84407 C.

Hot Water.

Preliminary Report of the Committee to Secure Data on Hot Water Heating. Gives Data covering present practice in various parts of the country. The subject is considered under the heads of boilers, radiation, and piping. 3000 w. Heat & Vent Mag—May, 1907. No. 84456.

Reasonable Hot-Water Heating Plants (Billige Warmwasserheizanlagen). E. Stadelmann. A short article on this subject with a prolonged discussion between the author and Fritz Gerlach. Diagram. 4500 w. Gesundheits Ing—April 13, 1907. No. 84183 D.

Mechanical Plant.

Heating and Ventilating the People's Palace, Boston. Detailed description of the mechanical plant for a five-story building for the Salvation Army. Heating is by direct radiation on the two-pipe system. Ventilation supplies a filtered air supply and exhausts foul air. Ills. 3500 w. Eng Rec—May 4, 1907. No. 84223.

Norway.

An Example of Heating Practice in Norway. Alf. Tjersland. Illustrated description of the usual type of heating system used, and an explanation of the method followed for determining the loss of heat from buildings and the amount of radiation needed. 1500 w. Met Work—May 18, 1907. No. 84357.

Refrigeration.

Mechanical Refrigeration. Alex. M. Blumenthal. An explanation of systems

of refrigeration, the processes and apparatus used. 3500 w. Engr, U S A—May 15, 1907. No. 84406 C.

Store-House Heating.

Cost of Heating Store Houses. H. O. Lacount. Investigates the cost of heating store-houses equipped with automatic sprinklers to prevent the freezing of the pipes. Compares with cost of dry-pipe, and calcium chlorid sprinkler equipments. 7000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84646 F.

Tunnels.

Ventilating a German Tunnel. Illustrated description of the ventilating plant for the Kaiser Wilhelm tunnel at Cochem. 1000 w. Engr, Lond—May 10, 1907. No. 84451 A.

HYDRAULICS.

Centrifugal Pumps.

The Roturbo Centrifugal Pump. Illustrates and describes a new type of centrifugal pump invented by E. S. G. Rees. 1600 w. Engr, Lond—May 17, 1907. No. 84586 A.

The Operation of Governing Mechanisms on Centrifugal Pumps and Blowers (Die Wirkung von Leitvorrichtungen bei Zentrifugalpumpen und Gebläsen). W. Grun. Mathematical discussion of various types. Ills. 5000 w. Zeitschr d Ver Deutscher Ing—April 6, 1907. No. 84142 D.

The Spiral Shell of Turbines, Centrifugal Pumps, etc. (Die Spiralgehäuse von Turbinen, Kreiselpumpen, usw.). Rudolf Lorenz. Mathematical discussion of its design. Ills. 2400 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84161 D.

Gates.

Water Power Plants with Waste Sluices for the Utilization of High Water (Wasserkraftanlagen mit Ejektorenschützen zur Ausnutzung von Hochwasser). Illustrated description of installations to prevent the drowning of the turbines during periods of high water, the first installment dealing with the plant at Chèvres. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84164 D.

Floating Gates in the Operation of Turbine Plants (Schwimmender Schützen zur Instandhaltung von Turbinenanlagen). A. Stoll. Illustrated description of an installation at Chèvres on the Rhone. 2000 w. Zeitschr f d Gesamte Turbinenwesen—April 20, 1907. No. 84160 D.

Pumping Machinery.

Pumping Machinery for the New Graving Dock, Colombo, Ceylon. Illustrations showing the machinery and general arrangement of the plant, with descriptive notes. 1000 w. Engng—May 17, 1907. No. 84577 A.

Rams.

Contribution to the Study of the Theory of the Hydraulic Ram (Contribución al Estudio de la Teoría de los Arietes Hidráulicos). Francisco Mirapeix. Mathematical paper. Ills. 6000 w. Serial. 1st part. Revista Tecno-Ind—March, 1907. No. 84125 D.

Stream-Flow Measurement.

See Mechanical Engineering, Measurement.

Theory.

Some Problems Connected with the Flow from Vessels (Alcuni Problemi sull' Efflusso dai Vasi). Pietro Alibrandi. A mathematical discussion of the whole subject of the flow of water through orifices. Ills. 80000 w. Ann della Soc Ing e d Arch Ital—Vol. XXI, No. 3. No. 84126 F.

Turbines.

Contribution to the Discussion of Water Flow in Turbines (Zur Diskussion der Wasserbewegung in Kreiselrädern). Herr Riebensahm. Discussion of Viktor Kaplan's article in this paper of Feb. 20. 1700 w. Zeitschr f d Gesamte Turbinenwesen—April 10, 1907. No. 84159 D.

Demonstration of the Correctness of the Present Common Turbine Theory on the Basis of Brake Tests on Turbine Plants in Actual Operation (Nachweis der Richtigkeit der derzeit gebräuchlichen Turbinentheorie auf Grund von Bremsproben an ausgeführten Turbinenanlagen). Viktor Kaplan. Answer to Dr. Lorenz's article of Feb. 28. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1907. No. 84163 D.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

Ball Bearings. Henry Hess. A discussion of their use in general and on automobiles in particular. Also Prof. Stribeck's reports on ball bearings for various loads. Ills. 18500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84649 F.

The Care and Repair of Bearings. Herbert L. Towle. Considers bearing materials, bearing fit, wear, repair, lubrication, etc. Ills. 3500 w. Rudder—May, 1907. No. 84264 C.

Boiler Making.

A Layout for a Boiler Maker. A. N. Lucas. Discusses flue work, patching, plugging cracks, stay-bolt work, renewing sheets in fire-boxes, building new boilers, etc. Diagrams. 2500 w. Boiler Maker—May, 1907. No. 84018.

Boring.

A Boring and Turning Mill. Illustrates and describes a mill of exceptionally strong design, adapted for work up to 100 in. in diameter and 4 ft. long. 800 w. Engr, Lond—May 3, 1907. No. 84347 A.

We supply copies of these articles. See page 687.

Brass Works.

The Langsenkamp - Wheeler Brass Works. Illustrated description of this Indianapolis plant. 1700 w. Foundry—June, 1907. No. 84597.

Brazing.

Brazing of Iron Surfaces. John L. Bacon. Materials and methods for joining cast and wrought iron are illustrated and described. 1500 w. Engr, U S A—May 1, 1907. No. 84036 C.

Car Wheels.

Modern Manufacture of Car Wheels (Die Moderne Fabrikation der Eisenbahnradsätze). Arthur Boeddecker. Illustrates and describes, in the first instalment, various machines for shaping spokes. 800 w. Serial. 1st part. Eisenbahntech Zeitschr—April 10, 1907. No. 84167 D.

Castings.

Aluminum Castings. E. F. Lake. Reviews the history of the discovery and development of the use of the metal aluminum, discussing the physical properties, and the making of aluminum castings. Ills. 2500 w. Foundry—May, 1907. No. 84058.

Bronze Castings for Automobiles. E. F. Lake. Considers the various combinations of alloys used to produce the different grades. 3000 w. Foundry—June, 1907. No. 84596.

Casting Copper. C. Vickers. Suggestions and discussion of the influence of various alloys. 1200 w. Foundry—June, 1907. No. 84598.

Casting Rolls for Bending Boiler Plate. R. H. Palmer. Illustrates and describes the method used. 1800 w. Foundry—June, 1907. No. 84591.

Defects in Foundry Practice with Especial Reference to Armature Casting (Fehler in der Giessereipraxis unter besonderer Berücksichtigung des Armaturengusses). H. Kloss. The first instalment of the serial discusses faults in construction, design, moulds and casting, and mixtures. 2300 w. Serial. 1st part. Stahl u Eisen—April 3, 1907. No. 84129 D.

False Back Repetition Casting. Walter J. May. Suggestions for making false backs or capes in plaster when economy is necessary. 1500 w. Prac Engr—May 3, 1907. No. 84335 A.

The Cores Used for the Large Dredge Cutter. John Gregson, Jr. Explains details of molding of a large cutter head for a suction dredge. 700 w. Am Mach—Vol. 30, No. 19. No. 84302.

The Skim-Gate and Its Value in Making Sand Castings. Illustrates and describes the "Renshaw skim-gate," explaining its value in making clean castings. 1700 w. Brass Wld—May, 1907. No. 84454.

Chains.

Weldless Chain Manufacture. Illustrates and describes the process employed by the Handelsgessellschaft Kleinberg & Co., Vienna, Austria. 1800 w. Ir Age—May 9, 1907. No. 84277.

Cleaning.

The Chemical Cleaning of Iron and Steel (Le Décapage Chimique du Fer et de l'Acier). E. Lemaire. A review of the methods used for cleaning iron and steel by means of acid baths in preparation for a protective covering, giving data as to loss of weight in baths of various acids. Ills. 4700 w. Génie Civil—April 27, 1907. No. 84119 D.

Cranes.

The Pawling & Harnischfeger Renewal Bulletins. An illustrated article explaining a system for facilitating the ordering of repairs or renewals for broken-down cranes. 1100 w. Ir Age—May 16, 1907. No. 84366.

Dies.

A Set of Shell-Drawing Dies for a Single-Acting Press. Julius F. A. Vogt. Illustrated description calling attention to new features. 1300 w. Am Mach—Vol. 30, No. 20. No. 84379.

Forging Press Dies for Making Hammers. Illustrates and describes their proper construction. 1500 w. Am Mach—Vol. 30, No. 18. No. 84038.

Drawing Presses.

The Calibration of Drawing-Press Tools (Die Kalibrierung der Ziehpresswerkzeuge). Karl Musiol-Warschau. Illustrated mathematical discussion of the proportioning of dies in drawing-press work. Tables. 2500 w. Serial. 1st part. Stahl u Eisen—April 3, 1907. No. 84128 D.

Epicyclic Trains.

Calculations Respecting Epicyclic Wheel Trains. Francis J. Bostock. Gives derivation of formulae for several usual types, and extension of the method of analysis to a somewhat complex epicyclic train. 1800 w. Diagrams. Am Mach—Vol. 30, No. 20. No. 84375.

Exposition.

Machine Tools at the International Automobile Exposition in Berlin, 1906 (Die Werzeugmaschinen auf der Internationalen Automobil-Ausstellung, 1906, in Berlin). The first instalment illustrates and describes various types of lathes and other machines exhibited. 1200 w. Serial. 1st part. Zeitschr f Werkzeugmasch—April 5, 1907. No. 84175 D.

Foundries.

A Modern Gray Iron Foundry. Illustrated description of the new plant of the Babcock & Wilcox Co., at Barberton, O., and of some of the molding methods. 2500 w. Ir Trd Rev—May 16, 1907. No. 84363.

We supply copies of these articles. See page 687.

Plant of the Scullin-Gallagher Iron & Steel Co. Illustrated description of a large steel foundry in St. Louis. 2500 w. Foundry—June, 1907. No. 84594.

Galvanizing.

The Art of Galvanizing. Alfred Sang. Read before the Am. Found. Assn. Remarks on corrosion and methods of protecting iron and steel, metallic coatings and their behavior, action of metals in contact, specifications for an ideal coating, cold, hot and dry galvanizing, etc. 5000 w. Ir Age—May 23, 1907. Serial. 1st part. No. 84486.

Gear-Cutting.

Two German Bevel Gear Shaping Attachments. Illustrates and describes two devices designed for planing bevel gears, using templets or cams in giving the proper shape to the tooth. 1500 w. Mach, N Y—May, 1907. No. 84021 C.

Gears.

Spiral Gearing by the Hindley Process. Illustrates and describes an extension of the Hindley principle to cover gears of low speed ratio with large increase in area of contact. 1000 w. Am Mach—Vol. 30, No. 20. No. 84374.

Guns.

Birmingham Small Arms. Illustrated description of this English plant for the production of these weapons, and some of the machines used. 5000 w. Engr, Lond —May 10, 1907. No. 84449 A.

Industrial Locomotives.

Industrial Locomotives (Die Baulokomotiven). A. Doeppner. Gives details of industrial locomotives of various powers and compares them with horses as regards cost of haulage. Ills. 2000 w. Zeitschr Ver Deutscher Ing—April 27, 1907. No. 84149 D.

Ingot Molds.

Note on the Distribution of Sulphur in Metal Ingot Molds. J. Henderson. Calls attention to the fact that much more sulphur is found in the tops of ingot molds, giving results of sampling from the top and bottom, and other matters of interest. 600 w. Ir & Coal Trds Rev—May 10, 1907. No. 84617 A.

Jig.

Improving a Milling Jig. George G. Little. Sketches and notes showing how a defective jig was made to give less trouble. 1000 w. Am Mach—Vol. 30, No. 21. No. 84491.

Lathes.

Motor Drive for Lathes. Illustrates and describes several interesting applications. 1200 w. Ir Age—May 9, 1907. No. 84276.

The Development of the Lathe (Die Entwicklung der Schnelldrehbänke). A historical sketch of the evolution of the lathe and lathe practice. Tables. 2000 w. Zeitschr f Werkzeugmasch—April 25, 1907. No. 84176 D.

Locomotive Works.

Baldwin Locomotive Works. John V. Martenis. A brief sketch reviewing the development of these works. Ills. 1600 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84626 N.

Machine Details.

A Factor in the Design of Machine Details. T. E. Stanton. Presents experimental evidence giving definite numerical results as to the loss of strength to be anticipated from such changes of section as are common in machine design when using the ordinary materials of construction. Ills. 1200 w. Engng—April 19, 1907. No. 84000 A.

Milling Cutters.

Tooth Relief for Milling Cutters—A Criticism. John Edgar. Discussing opinions of H. T. Millar, as expressed in an earlier article. Ills. 1600 w. Am Mach —Vol. 30, No. 21. No. 84489.

Mixers.

The Use of a Heated Foundry Mixer, J. B. Nau. Presents the advantages of the heated mixer, describing a design by the writer. 700 w. Ir Age—May 23, 1907. E + F.

Molding.

A Dry-Sand Mold with a Very Thin Core. Illustrates and describes an interesting way of making a mold in dry sand, with its very thin core, the method of supporting it and the pouring of the casting. 1000 w. Am Mach—Vol. 30, No. 19. No. 84299.

Molding Part of a Type-Casting Machine. R. H. Palmer. Describes methods of molding in dry sand and in green sand, and of treatment after pouring, in order to insure a satisfactory casting. Ills. 1500 w. Am Mach—Vol. 30, No. 20. No. 84380.

Ordnance.

The Ordnance Department as an Engineering Organization. William Crozier. An address delivered at the dedication of the Engineering Societies' building in New York, April 18, 1907. Ills. 8000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84644 F.

105-Millimetre and 120-Millimetre Quick-Firing Field Howitzers. Illustrated description of howitzers embodying the Ternstrom device for controlling automatically the length of recoil. 3000 w. Engng—May 10, 1907. No. 84443 A.

Patterns.

A Double Chute Hopper Pattern. H. J. McCaslin. Describes the construction of the core boxes and methods of molding. Ills. 1600 w. Foundry—May, 1907. No. 84060.

Pattern for a Heavy Ajax Forging Ma-

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chine Frame Casting. Jabez Nall. Illustrates and describes the method of molding. 4000 w. Foundry—June, 1907. No. 84592.

Pig Iron.

Foundry Pig Iron Specifications. Herbert Pilkington. Read before the British Found. Assn. Discusses conditions in connection with the production of pig iron, grading, silicon variation, sulphur, remelting, etc. 3000 w. Foundry—June, 1907. No. 84595.

Sand Blasts.

Sand Blasting Appliances. J. M. Betton. On the proper arrangement of cleaning rooms with suggestions for their equipment. 1400 w. Foundry—June, 1907. No. 84593.

Shop.

A Shop with a History. H. P. Fairfield. Illustrated review of the history of the Putnam shop in Fitchburg, Mass. 1500 w. Mach, N Y—May, 1907. No. 84019 C.

Structural Steel.

An Electrically Operated Structural Plant. Illustrated description of a plant for manufacturing ornamental and structural steel work for buildings and bridges. 1600 w. Eng Rec—May 4, 1907. No. 84224.

Taps.

Cutting Taper Threaded Taps with Chasers. Erik Oberg. Considers the conditions of cutting a taper thread with a chaser, particularly the case of a pipe tap with a total taper of ¾ in. per foot, cut with a chaser supposed to be held in a threading tool-holder. Diagrams. 900 w. Mach, N Y—May, 1907. No. 84022 C.

Tempering.

Furnaces for Tempering High-Speed Steel. C. U. Scott. Suggestions for the fitting up of a hardening room, and the treatment of the tools. 1500 w. Am Mach—Vol. 30, No. 19. No. 84301.

The Exposition of Tempering Processes (Exposition des Procédés de Trempe). M. Ch. Rosambert. Descriptions of the furnaces, pyrometers and processes shown at this exposition at Vienna, May-July, 1906, with brief reviews of the technical papers read at the conferences of metallurgists held in connection. Ill. 12500 w. Rev d Metal—April, 1907. No. 84100 E + F.

Thread Tools.

Thread Tools for Threads with Rounded Top and Bottom. E. A. Johnson. Describes the tools and methods used in making the Whitworth thread tools. Diagrams. 1200 w. Mach, N Y—May, 1907. No. 84020 C.

Tools.

High-Speed Steel Tools. E. R. Norris. Discusses the making, life, and shape of the tool, its applications, etc., referring to other papers on this subject. 4500 w. Elec Jour—May, 1907. No. 84475.

Westinghouse.

A brief History of the Westinghouse Machine Company. Edward H. Sniffin. Review of the period covering the manufacture of steam engines, gas engines, steam turbines, and stokers. 4500 w. Elec Jour—May, 1907. No. 84476.

Wire.

The Telephone Wire Plant. Sergius P. Grace. Explains some of the factors in the design of the wire plant, and discusses some of the problems. Ills. 4000 w. Pro Am Inst of Elec Engrs—April, 1907. No. 84518 D.

MATERIALS OF CONSTRUCTION.

Automobiles.

Material for Automobiles. Elwood Haynes. An examination of the various metals used, and the parts for which certain materials are adapted. 3500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84639 F.

Special Auto Steel. Thomas J. Fay. Gives 4 tables of data of the various grades of steel, stating the results of reliable tests, and giving a detailed discussion of the relative value of the several products. Ills. 7000 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84647 F.

Cast Iron.

Chemical Properties of Malleable Cast-Iron. G. A. Akerland. Compares malleable and gray iron, showing annealing changes, and giving tests and experiments. 1200 w. Foundry—June, 1907. No. 84590.

Manganese Steel.

Manganese Steel and Some of Its Uses. E. F. Lake. Calls attention to some of the peculiarities of this material, and its advantages over carbon steel for rails subject to severe wear, for burglar-proof vaults, etc. 2000 w. Amr Mach—Vol. 30, No. 20. No. 84378.

Screws.

Standard Proportions for Machine Screws. Revised report of the committee on standard proportions for machine screws. 2500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84500.

Steel.

Carbon Tungsten Steels. Thomas Swinden. An investigation of varying percentages of carbon in the presence of a constant percentage of tungsten. 5500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84619 A.

The Ageing of Mild Steel. C. E. Stromeyer. A report of the writer's investigations, describing tests made. 1100 w. Ir & Coal Trds Rev—May 10, 1907. No. 84620 A.

Steel Sheets.

I. History of the Development of the Manufacture of Iron and Steel Sheets. W.

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C. Cronemeyer. II. Sheet Metal Manipulation. Frank I. Ellis. Two papers discussed together. Ills. 11000 w. Pro Engrs' Soc of W Penn—May, 1907. No. 84624 D.

Steel Tubes.

Pressures on Lap-Welded Steel Tubes. Prof. Reid T. Stewart. Supplement to an earlier paper on the effects of the distortion due to successive re-tests on the collapsing pressures of 10-inch lap-welded steel tubes. 1500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84501.

Tool-Steel.

An Analysis of the Evolution of Modern Tool-Steel. Prof. H. C. H. Carpenter. A paper inspired by the presidential address of F. W. Taylor, aiming to trace the evolution of tool steel in the light of recent knowledge. The present number considers current theories of hardening, and the wear of tools in cutting metals. 4800 w. Engng—May 3, 1907. Serial. 1st part. No. 84340 A.

Vanadium Steel.

Some Properties of Vanadium Steel. E. F. Lake. How small quantities of vanadium affect iron and steel and where it is most useful. 2500 w. Am Mach—Vol. 30, No. 18. No. 84039.

Wire Rope.

The Strength of Wire Rope (Die Beanspruchung von Drahtseilen). J. Isaachsen. Mathematical discussion of the stresses set up in wire rope under tension and flexure. Diagrams. 5000 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84148 D.

MEASUREMENT.

Cooling Curves.

Methods in Obtaining Cooling Curves. C. L. A. Schmidt. Brief explanation of methods, with illustrations of apparatus used. 1600 w. Cal Jour of Tech—May, 1907. No. 84650.

Hardness.

Testing Hardness of Metals and Materials. W. J. Ballentine. Describes a process making use of a new form of impact-testing instrument which is simple in construction. 1700 w. Am Mach—Vol. 30, No. 20. No. 84377.

Polygons.

Computation Table for Regular Polygons. W. L. Benitz. Gives two tables aiming to simplify the calculations for any required dimensions of regular polygons. 800 w. Am Mach—Vol. 30, No. 21. No. 84490.

Stream Flow.

Methods Employed by the U. S. Geological Survey for Obtaining Winter Records of Stream Flow by Means of Current Meter Stations. Information from a paper by H. K. Barrows and Robert E. Horton. 1500 w. Engng-Con—May 15, 1907. No. 84365.

Lea's Patent Water Recorder. Illustrates and describes an instrument for measuring and recording graphically the rates of flow of water or other liquid when passing freely over weirs or through orifices. 1800 w. Mech Engr—April 27, 1907. No. 84244 A.

Temperature.

Practical Pyrometry. Robert S. Whipple. Illustrates and describes many types of thermometers and some of the applications. Discussion. 6500 w. Jour W Soc of Engrs—April, 1907. No. 84529 D.

Sentinel Pyrometers and Their Application to the Annealing, Hardening, and General Heat Treatment of Tool Steel. Harry Bearley and F. Colin Moorwood. An account of the use of sentinel pyrometers showing their practical utility. 3000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84618 A.

Wind Gage.

A New Direct-Reading Wind Gage. Dr. Alfred Gradenwitz. Illustrates and describes a novel wind gage constructed by Max Kohl, and also a wind gage constructed on plans by E. Geyer which renders it possible to read the direction of the wind both by day and night at any distance. 1200 w. Sci Am Sup—May 18, 1907. No. 84394.

POWER AND TRANSMISSION.

Air Compressors.

The New Franklin Air Compressors. Illustrated description of compressors made in Chicago. 1600 w. Ir Age—May 9, 1907. No. 84278.

Crane-Hooks.

An Experimental Investigation of the Maximum Stresses in Loaded Crane-Hooks. John Goodman. A comparison of old and new theories, giving data obtained by experiment upon wrought-iron crane-hooks. 3300 w. Inst of Civ Engrs—No. 3655. No. 84461 N.

Economics.

Economy in Power. A. Stucki. Discusses the question of relative economy in fuel and briefly considers the cost and maintenance of the installation, reliability, safety, attendance, and adaptability. 2500 w. R R Gaz—May 10, 1907. No. 84288.

Power Costs. Charles E. Lucke. Read before the Am. Elec. Chem. Soc. A comparison of costs of water, steam, oil, and gas power, with discussion. 4800 w. Elec Rev, N Y—May 18, 1907. No. 84415.

Electric Power.

Electrically Operated Equatorial Mountings for Telescopes. Illustrates and describes the construction recently invented by Herr F. Meyer, in which electricity is the motive power used. 1200 w. Sci Am Sup—May 18, 1907. No. 84393.

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Breaking the Record in Newspaper Making. Day Allen Willey. Illustrated description of the new plant of the Baltimore *Sun*, which is electrically driven. 2000 w. Elec Rev, N Y—May 18, 1907. No. 84414.

The Electric Plant at the Burbacher Hutte. Illustrated description of the electrical equipment of these German steel works. 1200 w. Engr, Lond—May 17, 1907. No. 84587 A.

An Electrically Driven Cement Works. Illustrated description of works at West Hartlepool recently changed from oil-engines to three-phase induction motors. 2500 w. Elec Engr, Lond—May 17, 1907. No. 84573 A.

Elevator Capacity.

The Comparative Capacity of Elevators and Escalators for Handling Crowds. Charles D. Seeberger. Concludes that the platform area per unit of time affords a perfect standard for comparison. 900 w. Eng News—May 2, 1907. No. 84043.

Elevators.

Boddam's Hydro-Electric Lift. Illustrates and describes an arrangement having the advantages of the hydraulic lift and the electrically driven lift combined. 1000 w. Engng—May 17, 1907. No. 84580 A.

Gas Plant.

A New Producer Gas Plant. Illustrated description of a plant installed in a Chicago factory. 1500 w. Engr, U S A—May 1, 1907. No. 84037 C.

Pneumatic Tools.

Some Late Improvements on Compressive Riveters and Other Tools. Chester B. Albree. An illustrated talk on new features recently introduced. Discussion. 4500 w. Pro Engrs' Soc of W Penn—May, 1907. No. 84625 D.

Power Plants.

Hydro-Electric Power versus Steam for Industrial Plants. H. von Schon. This third article of a series describes some typical modern stations, and calls attention to undeveloped powers in various parts of the United States. Ills. 7000 w. Engineering Magazine—June, 1907. No. 84193 B.

A Model Plant in a Fine Office Building. Illustrated description of the plant for heating and electric light, motors being supplied for driving elevator pumps, printing presses, and ventilation fans, for the building of the Security Mutual Life Insurance Co., at Binghamton, N. Y. 3000 w. Engr, U S A—May 1, 1907. No. 84035 C.

STEAM ENGINEERING.

Boilers.

Efficiency in Steam-Boiler Practice. Percival Cooke. Treats of the efficient performance of steam boilers from the position of the manufacturer. Ills. 4500 w. Cassier's Mag—May, 1907. Serial. 1st part. No. 84052 B.

Automatic Counter-Current and Water-Circulating Device for Fire and Water-Tube Boilers (Selbsttätiger Gegenstrom- und Wasserumlauf-Erzeuger von Kunert für Flamm- und Heizrohrkessel). Herr Förster. Illustrated detailed description of the device and results of elaborate tests of its efficiency. 4500 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84146 D.

Combustion.

Efficiency in the Burning of Fuel Under the Steam Boiler. William D. Ennis. This first article of a series deals with the influence of air supply upon economy of combustion, the means of discovering whether the conditions are right in any given plant, and the remedies needed. 5500 w. Engineering Magazine—June, 1907. No. 84179 B.

Engine Wreck.

An Unusual Engine Wreck. Milton W. Arrowood. Describes an accident to an engine used to furnish power for a large grain elevator, and the method of repair. Ills. 1000 w. Am Mach—Vol. 30, No. 20. No. 84381.

Fuel.

Burning Fine Anthracite Coal. R. T. Strohm. Discusses points in connection with the successful burning of low-grade fuel, types of furnace, firing, etc. Ills. 2500 w. Elec Wld—May 4, 1907. No. 84212.

Lubricants.

Deflocculated Graphite and the "Acheson Effect." Orrin E. Dunlap. Describes a recent invention of E. G. Acheson which reduces graphite practically to the molecular state, stating some of its possibilities as a lubricant. 2000 w. Sci Am—May 11, 1907. No. 84326.

The Properties and Use of Mineral Lubricating Oils. P. F. Walker. Considers methods of testing oils for their friction-reducing values, showing the need of investigating all phases of the oil question, especially the film-forming properties. 4000 w. Engineering Magazine—June, 1907. No. 84635 B.

Oil Burners.

The Application of Oil Burners to Steam Boilers. William Kavanagh. Gives some facts pertaining to oil burners, their structure and application to steam boilers. Ills. 1500 w. Elec Wld—May 4, 1907. No. 84211.

Pumping Engines.

Balancing of Pumping Engines. A. F. Nagle. An investigation as to the proper weight of the plungers of a vertical, triple-expansion, crank and flywheel pumping engine. 1600 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84502 F.

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Smokestacks.

The Calculation of Smokestacks for Manufactories (Die Berechnung von Fabrikschornsteinen). C. Gaab. Discusses the findings of a commission appointed by the Prussian Minister of Public Works to investigate conditions of safe construction of smokestacks. 6200 w. Zeitschr d Ver Deutscher Ing—April 27, 1907. No. 84147 D.

Superheating.

Entropy Lines of Superheated Steam. Arthur M. Greene, Jr. Gives results of experiments of Knoblauch and Jakob. Curves and diagrams. 1500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84645 F.

Experiences with Superheated Steam. George H. Barrus. Notes dating back to 1874 on the writer's experiences with superheated steam. 2500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84504 F.

Flow of Superheated Steam in Pipes. E. H. Foster. Gives conclusions reached from data collected, showing that the laws governing the flow of superheated steam differ from those governing saturated steam. 700 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84505 F.

Specific Heat of Superheated Steam. Discussion by R. W. Stovel of the paper by A. R. Dodge on this subject. 1400 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84507 F.

Materials for the Control of Superheated Steam. M. W. Kellogg. Deals particularly with pipe, fittings, valves, and the details connected therewith, such as joints, gaskets, etc. 2300 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84648 F.

Superheat and Furnace Relations. Reginald Pelham Bolton. Considers methods of generating superheated steam, and their improvement. 1400 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84637 F.

Superheated Steam on Locomotives. H. H. Vaughan. On the use of superheated steam on locomotives in the United States and Canada, illustrating and describing types of superheaters applied, giving economical results, and maintenance results, and conclusions. 3500 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84640 F.

The Cole Locomotive Superheater. W. F. M. Goss. Notes concerning the performance of the Cole superheater as applied to the Purdue University locomotive "Schenectady No. 3." 1000 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84506 F.

Use of Superheated Steam in an Injector. Strickland L. Kneass. Note on the essentials to obtain good results from an injector with superheated steam. 500 w. Pro Am Soc of Mech Engrs—May, 1907. No. 84503 F.

Turbines.

The Steam Turbine (Die Dampfturbine). Herr Hofweber. General review of the principles of the various types of steam turbine describing their construction, with special reference to the Zoelly turbine. Ills. 5000 w. Two parts. Zeitschr d Oest Ing u Arch Ver—April 12 and 19, 1907. No. 84179 each D.

The Ideal Condensation for Steam Turbines for Land and Marine Service (Die ideale Kondensation für Land- und Schiffs-Dampfturbinenanlagen). Felix Langen. The first instalment describes various systems of condensation. 1000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 20, 1907. No. 84162 D.

Turbine Tests.

Tests of a 2000 Horse Power Riedler Steam Turbine (Versuche an einer 2000 Pferdigen Riedler-Stumpf-Dampfturbine). F. Rötscher. Describes the turbine which was coupled to a 1400-kw. asynchronous A. C. generator and gives the results of elaborate tests. Ills. 4500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 20, 1907. No. 84144 D.

Valve Gears.

Valve Gears for Engines. P. E. Merriam. Illustrates and describes types of valves and valve gears and their adjustment. 1600 w. Engr, U S A—May 15, 1907. No. 84405 C.

Valve Gear for High-Speed Engines. A. Houlson. Investigates the method of determining the correct proportions of cylinders, valves, and valve gear for a modern high-speed vertical enclosed engine. Ills. 2400 w. Mech Engr—May 4, 1907. Serial. 1st part. No. 84336 A.

MISCELLANY.

Aeronautics.

The Future of Aerial Navigation (Die Zukunft der Luftschiffahrt). Georg Wellner. Describes several types of air ship and outlines the mathematical principles on which the design and construction of a successful air ship must be based. Diagrams. 4000 w. Zeitschr d Oest Ing u Arch Ver—April 26, 1907. No. 84181 D.

Capt. Ferber's Aëroplane Experiments. Illustrates the apparatus and describes the experiments of this French aëronaut. 900 w. Sci Am—April 13, 1907. No. 83579.

The Aero Club's Exhibit at the Agricultural Hall. Illustrates and describes some of the models shown. 2500 w. Auto Jour—April 13, 1907. Serial. 1st part. No. 83865 A.

The Development of the Air-Ship Motor (Die Entwicklung der Motor Aëronautik). Walter Oertel. Description of a large number of aeronautic motors. Serial. 4500 w. First part. Zeitschr d Mitteleuropäischen Motorwagen Vereins—No. 5, March, 1907. No. 83655 D.

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Aeroplane Model Trials. An illustrated account of the competitive trials at the Alexandra Palace, April 15, 1907. 2200 w. Auto Jour—April 20, 1907. No. 83985 A.

Aerial Navigation. Major B. F. S. Baden-Powell. Considers the importance of the subject, discussing some of the general principles of aerodynamics, and stating facts in regard to recent machines. Also discussion. 7000 w. Jour Soc of Arts—April 19, 1907. No. 83982 A.

Adding Machine.

The Burroughs Adding and Listing Machine. Illustrates and describes an efficient adding machine used extensively in banks and clearing houses. 3500 w. Engng—May 3, 1907. No. 84342 A.

Air Flow.

The Flow of Air in Long Tubes with Special Reference to Pneumatic Dispatch. B. C. Batcheller. Formulae expressing the flow of air in tubes, illustrated by examples. 2500 w. Compressed Air—April, 1907. Serial. 1st part. No. 83952.

Dry Air.

Properties of Dry Air (Vom Trocknen). Otto Marr. Physical and chemical properties of air having different degrees of temperature and water vapor. Diagrams and tables. Serial. First part. 3300 w. Gesundheits Ingenieur—Dec. 8, 1906. No. 83665 D.

Liquefaction.

Machines for the Making of Liquid Air (Les Machines pour la Liquéfaction de l'Air). H. Demierre. General discussion of the problem of liquifying air and description of the Linde and Hampson machines. Ill. 2600 w. Bull Tech d l Suisse Rom—April 10, 1907. No. 83674 D.

The Liquefaction of Gases. Roger Baldwin Colton. Brief review of the progress made and the methods used. Ills. 1500 w. Yale Sci M—April, 1907. No. 83919 C.

Mechanics.

The Lack of Clearness in Some of the Fundamental Principles of Theoretical Mechanics (Mangelnde Klarheit in einigen Grundbegriffen und Principien der Theoretischen Mechanik). Karl Rudolf. The first part discusses the theory of rotating bodies with reference to centrifugal force. Ills. 2700 w. Serial. 1st part. Elektrotech u polytech Rundschau—April 10, 1907. No. 84169 D.

Oxygen.

The Manufacture of Oxygen. An account of the plant of the British Oxygen Company, with illustrations, especially describing the Linde liquid-air plant installed. 2000 w. Engng—April 19, 1907. No. 84001 A.

Seamless Tubing.

An Important Seamless Tubing Decision. Gives the decision sustaining the Shelby Steel Tube Co. in regard to the original Stiefel piercing mill. 3500 w. Ir Age—April 4, 1907. No. 83435.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

Coal Analysis from the Commercial Point of View. J. T. Dunn. Outlines the principles of methods of analysis, showing how far the results give the desired information, and gives related matter of interest. 3500 w. Col Guard—May 10, 1907. Serial. 1st part. No. 84441 A.

Breaker.

Breaker of the Pacific Coal Company in Alberta. Lewis Stockett and B. R. Warden. Plan, sections and description of this recently erected breaker for the preparation of anthracite coal. 2700 w. Eng & Min Jour—May 4, 1907. No. 84219.

Coal Washing.

Some Principles of Coal Washing. Classifies and discusses the impurities found in coal and methods of removing them; the significance of settling laws with reference to coal-washing; coal-washing devices, etc. Ills. 6000 w. Can Min Jour—May 15, 1907. No. 84401.

The Production of Coke and Its Application in Domestic Fires. Paul Schlicht. Considers the use of bituminous coal, the production of coke, kinds of coke, its application in domestic fires, and illustrates and describes a new method of combustion. Discussion follows. 11000 w. Jour Soc of Arts—May 10, 1907. No. 84431 A.

Conveyors.

Conveyor-System for Loading at the Coal-face. Floyd W. Parsons. Explains this method of operation and its advantages. 1500 w. Eng & Min Jour—May 18, 1907. No. 84423.

Disaster.

The Warrior Run Mine Disaster. Charles Enzian. Describes methods used in combatting a mine fire accompanied by a squeeze and large quantities of explosive gas. 6000 w. Mines & Min—May, 1907. No. 84062 C.

Electric Power.

Electric Power in Durham Colleries. An illustrated article giving details of the power house equipment and a description of colliery plant. 1500 w. Elec Rev,

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Lond—April 26, 1907. Serial. 1st part. No. 84246 A.

Electrification of the Lambton Collieries. Illustrates and describes a plant of the alternate-current type. 2400 w. Ir & Coal Trds Rev—May 3, 1907. No. 84350 A.

Colliery Hoisting, Haulage and Power Systems. Franz Erich Junge. Compares the cost of individual steam-driven hoist and power units with that of the central electric power-station system. 4000 w. Eng & Min Jour—May 11, 1907. No. 84313.

Germany.

The Coal District Northeast of the Ruhr as Disclosed by Borings and Comparison with the Cardiff District (Das Steinkohlengebiet nordöstlich der Roer nach den Ergebnissen der Tiefbohrungen und verglichen mit dem Cardiff-Distrikt). Drs. Krusch and Wunstorf. The geology of this district, stratigraphy as disclosed by numerous borings and comparison with the South Wales fields. Plates. 8000 w. Glückauf—April 13, 1907. No. 84151 D.

Comparison Between the Roer Coalfield and the Cardiff District. Krusch and Wunstorf, in *Glückauf*. Map. With descriptive comparison. 1100 w. Col Guard —May 3, 1907. No. 84339 A.

Haulage.

Shunting Railway Wagons by Ropes. James Tonge. Describes the Heckel shunting system, in which the work is done by an endless wire rope which runs parallel to the rails. 900 w. Ir & Coal Trds Rev—May 3, 1907. No. 84349 A.

Mechanical Haulage Arrangements at the Pit Head of Shaft II. of the Neumühl Mine (Die mechanische Förderungsanlage an der Hängebank von Schacht II der Zeche Neumühl). Herr Stapff. Illustrated detailed description of an arrangement which handles the cars from the cage to their final destination. 2000 w. Glückauf—April 6, 1907. No. 84150 D.

Rescue Apparatus.

New Breathing Apparatus (Neuerungen an Atmungsapparaten). Herr Grahn. New types of rescue apparatus are illustrated and described. 1800 w. Glückauf —April 20, 1907. No. 84152 D.

Sampling.

Coal Sampling. Dr. J. E. Woodman. Read before the Nova Scotia Min. Soc. Aims to show the results of work done in connection with the U. S. Geol. Surv. testing plants at St. Louis. 2500 w. Can Min Jour—May 1, 1907. No. 84087.

Spontaneous Combustion.

The Spontaneous Combustion of Coal Fields and Alteration of Overlying Strata. A. Lakes. Describes remarkable changes in the Colorado coal fields caused by intrusions of igneous or eruptive rocks, or by spontaneous combustion. 800 w. Min Rept—May 2, 1907. No. 84200.

Storage.

See Civil Engineering, Construction.

COPPER.

British Columbia.

Methods of Mining in the Boundary District, British Columbia. Frederic Keffer. Describes recent low-cost systems which have made possible the profitable mining of low-grade copper ores. Ills. 2800 w. Engineering Magazine—June, 1907. No. 84199 B.

Copper Mining an Important Industry in British Columbia. E. Jacobs. An illustrated review of the development and progress at various camps, with statistics of production, etc. 7000 w. B C Min Rec—March, 1907. No. 84265 B.

Desulphurizing.

The McMurtry-Rogers Process for Desulphurizing Copper Ores and Matte. T. C. Cloud. Describes the treatment of ore by this process. 5000 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84013 N.

Extraction.

New Electrolytic Process for Extraction of Copper from Ore. W. Stoeger. Trans. from *Rev. d'Electrochimie et d'Electrometallurgie*. Describes the Larszcynski process and its industrial application. 1700 w. Min Jour—April 27, 1907. No. 84251 A.

Smelting.

The Chief Advances in Copper Smelting in Modern Times. William Gowland. Presidential address. Considers the increase in the production of copper and the means by which it has been brought about. Ills. 10000 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84011 N.

Some Paradoxes of Matte Smelting. David H. Browne. Calls attention to some curious things observed in matte smelting. 1500 w. Can Min Jour—May 1, 1907. No. 84085.

Chrome Plant of U. S. Metals Refining Company. Lawrence Addicks. Illustrated description of a new copper-smelting plant and electrolytic refinery in course of construction. 3000 w. Eng & Min Jour—May 25, 1907. No. 84572.

The Copper-Smelting Works at Humboldt, Ariz. E. H. Hamilton. Illustrated description of the plant of the Arizona Smelting Co. which is electrically driven and employs fuel-oil furnaces. 1500 w. Eng & Min Jour—May 11, 1907. No. 84314.

Utah.

Mining at Bingham, Utah. James W. Abbott. An illustrated account of this camp worked at first for gold, silver and lead, but finally developing into a great copper mine. 1500 w. Min & Sci Pr—May 11, 1907. No. 84367.

We supply copies of these articles. See page 687.

GOLD AND SILVER.

Assaying.

Some Experiences in Assaying Telluride Ores. J. N. McLeod. Reports assays of ores containing either high percentages of tellurium, or tellurium with other metals, which apparently had a marked effect on the results. 1800 w. Min Wld—May 18, 1907. No. 84411.

The Screen Assay on the Meyer and Charlton G. M. Under "The New Metallurgy." Chris Toombs. Reports results obtained by screen assay in the presence of cyanide solution. 2000 w. Jour Chem, Met & Min Soc of S Africa—March, 1907. No. 84432 E.

Battery Foundations.

Battery Foundations of the Kuk-San-Dong Mill, Korea. Charles D. Kaeding. Illustrates and describes concrete mortar piers and battery foundations of a somewhat unusual type. 600 w. Min & Sci Pr—May 11, 1907. No. 84368.

Black Sands.

The Auriferous Black Sands of California. J. A. Edman. Introductory remarks, with a statement of the origin, distribution and probable values of the heavy black sands on the Pacific Coast, from the standpoint of the miner and metallurgist. 2200 w. Min Rept—May 2, 1907. No. 84201.

Cobalt.

Cobalt. An account of the geology of the region and of the number and extent of development of the principal mines. Ills. 4000 w. Mines & Min—May, 1907. Serial. 1st part. No. 84065 C.

Colorado.

The Joker Drainage Tunnel. R. L. Herrick. An account of this once famous mining region, explaining the causes for the cessation of mining, reviewing the geology and describing the reopening of the mines, tunnel driving, etc. The district contains silver, lead and copper ores and other minerals of value. Ills. 5000 w. Mines & Min—May, 1907. No. 84067 C.

Concentration.

The Hercules Mill. Scott Turner. Describes this most recent concentrating plant of the Cour d'Alene region, as typifying the most approved lead-silver milling methods in northern Idaho. 3000 w. Min & Sci Pr—May 4, 1907. No. 84306.

The Sherman Concentrating Table. C. Everard Arnold. Sketch, plan and description. 600 w. Min & Sci Pr—May 11, 1907. No. 84369.

Elmore Process.

Ore Concentration by Oil. Diagram and description of the process invented by F. E. Elmore, with illustrations. 1600 w. Engr, Lond—May 10, 1907. No. 84448 A.

Vacuum-Flotation Process for Concentration. Alexander Stanley Elmore. Describes the method of operation of the Elmore process which employs reduced pressure to increase by expansion the lifting power of gas bubbles in a liquid medium. 1200 w. Eng & Min Jour—May 11, 1907. No. 84316.

Honduras.

Mining in Honduras. Horace G. Nichols. Describes the character of the deposits, methods of mining, labor, etc. Gold and copper and other minerals of value are found. Ills. 3000 w. Min & Sci Pr—May 11, 1907. No. 84370.

Idaho.

The Gold of the Snake River. Robert N. Bell. A detailed description of these low-grade deposits. Ills. 1500 w. Min & Sci Pr—April 27, 1907. No. 84091.

The Murray Gold Belt, Idaho. Theo. L. Lammers. Describes the formation of this district, the deposits, and gives an account of the development. 1600 w. Min & Sci Pr—May 18, 1907. No. 84602.

Mexico.

History and Development of Batopilas Mine, Mexico. Stuart Tod. Outlines the early history of this silver mine, and its present condition. Ills. 3000 w. Min Wld—May 4, 1907. No. 84237.

Metallurgical Development at Guanajuato. T. A. Rickard. An illustrated description of the reduction works at the Sirena mill, with an account of their development. 2500 w. Min & Sci Pr—May 18, 1907. No. 84600.

Mines and Prospects of Sierra Almoloya. Robert Thomas Hill. An account of the Cigarrero Mine, and of the Iguana Mine, in the Almoloya mountain district of Mexico. Ills. 1000 w. Min Wld—May 4, 1907. No. 84232.

The Dolores Mine, Chihuahua, Mexico. John B. Farish. Section and description of the veins and the development. 500 w. Eng & Min Jour—May 4, 1907. No. 84216.

The Geology of the Veta Madre. T. A. Rickard. Gives plan and sections of the Veta Madre, with description of the rich silver deposits. 3500 w. Min & Sci Pr—April 27, 1907. No. 84090.

Mines.

The Great Gold Mines. T. A. Rickard. Some facts in regard to the leading gold mines of the present day, their productiveness, and ore values. Considers the Robinson, in the Transvaal, the greatest gold mine yet worked. 2500 w. Min & Sci Pr—May 4, 1907. No. 84305.

Nevada.

The Renaissance of Nevada. Remarks on the recent revival of mining in the deserts of Nevada, the leading features in

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the development, the deposits of gold, silver and copper, etc. 2000 w. Min & Sci Pr—May 4, 1907. No. 84307.

The Gold Mountain District, Nevada. F. L. Ransome. Describes this district and the gold and silver ores, and the principal mines. 1500 w. Min Rept—May 2, 1907. No. 84202.

Placers.

British Columbia Placers: Past and Present. Horace F. Evans. Interesting information concerning the early placer mining of British Columbia. 1800 w. Min Wld—May 4, 1907. Serial. 1st part. No. 84234.

Placer Dredging in California. George L. Holmes. An illustrated account of the development and success of this industry, showing types of dredges used. 1600 w. Min Wld—May 25, 1907. No. 84603.

Gold Dredging in Europe (Die Goldbaggerie in Europa). L. St. Rainer. Read before the Mining and Metallurgical Section of the Austrian Society of Engineers and Architects. Discusses the gold-bearing streams and the dredging operations. 2800 w. Serial. 1st part. Oest Zeitschr f Berg und Hüttenwesen—April 27, 1907. No. 84136 D.

Russia.

A Visit to the Gold Fields of Orenburg, Russia. F. H. Hatch. Describes peculiarities of this district, noticed during recent travels. 2200 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84012 N.

IRON AND STEEL.

Assaying.

A Method for the Estimation of Iron in Presence of Titanium. F. A. Gooch and H. D. Newton. Describes an investigation undertaken for the purpose of adapting the ordinary process of reducing the ferric salt by zinc to the estimation of iron in presence of titanium. 700 w. Am Jour of Sci—May, 1907. No. 84016 D.

Determination of Silica and Alumina in Iron Ores. Graham W. Dean. Gives the method of procedure when silica only is required, and also when alumina is required. 2000 w. Min Wld—May 11, 1907. No. 84308.

Blast Furnaces.

The Blast Furnace Practically and Theoretically Considered. W. J. Foster. Read before the Saffordshire Ir. & St. Inst. An examination of the processes involved in working a blast furnace. 5500 w. Ir & Coal Trds Rev—April 19, 1907. No. 84009 A.

The Application of the Centrifugal Dust Collector to the Blast Furnace. Frank C. Roberts. Briefly reviews the development of devices for the removal of dust and dirt from the waste gases of the blast furnace and gives results obtained by the use of the centrifugal dust collector. 1400 w. Ir Trd Rev—May 9, 1907. No. 84270.

Charging Machines.

Machines for Charging Metallurgical Furnaces (Machines à Charger les Fours Métallurgiques). Ch. Dantin. Illustrated description of machines for charging Martin furnaces and machines for handling ingots and ingot moulds. 2500 w. Génie Civil—April 20, 1907. No. 84115 D.

Electric Power.

Electric Power in Iron and Steel Works. D. Selby Bigge. Read before the Ir. & St. Inst. On the development of electricity in the iron and steel industries, with special reference to its latest application to reversing rolling mills of high power. Explains the advantages and points of special interest, giving a description of the Hildegarde Works. Ills. 8500 w. Engng—May 10, 1907. No. 84447 A.

The Development of Electricity in the Iron and Steel Industries, with Special Reference to Its Latest Application to Reversing Rolling Mills of High Power. D. Selby Bigge. Illustrations and diagrams. 8500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84612 A.

The Electric Power Installation at Grangesberg Iron Mines, Sweden. G. Ralph. Abstract of a paper read before the Newcastle Loc. Sec. of Inst. of Elec. Engrs. A descriptive article, with illustrations. 2500 w. Ir & Coal Trds Rev—May 3, 1907. No. 84348 A.

Electric Smelting.

Preliminary Report on the Experiments on the Electric Smelting of Canadian Iron Ores, Carried Out Under Government Auspices at Sault Ste. Marie (Vorläufiger Bericht über die in Sault St. Marie unter dem Protektorat der Regierung angestellten Versuche zur Schmelzung Kanadischer Eisenerze Vermittels der Elektrothermischen Methode). Dr. Eugen Haanel. Ills. 1200 w. Serial. 1st part. Elektrochem Zeitschr—April, 1907. No. 84132 G.

Great Britain.

The Iron Ore Supplies of Great Britain. T. Good. A discussion of the British iron ore resources, claiming there are vast reserves available. 2500 w. Cassier's Mag—May, 1907. No. 84050 B.

Induced Draught.

Induced Draught, with Hot-Air Economizers, for Steel Works and Blast Furnace Boilers. A. J. Capron. Describes a system that has been in use for marine purposes for about ten years, and recently has been coming into extensive use for land boilers. Ills. 3000 w. Ir & Coal Trds Rev—May 10, 1907. No. 84616 A.

Ironstone.

The Ironstone of Cleveland. Arthur E.

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Pratt. Describes the geology and mining methods, and the calcination. 4500 w. Inst of Min & Met, Bul 31—April 11, 1907. No. 84015 N.

Iron Works.

The Works of the Atikokan Iron Company, Limited. Illustrates and describes the new blast furnace, ore roasting kilns, and coking plant at Port Arthur, Ontario. 1500 w. Ir Age—May 2, 1907. No. 84029.

Magnetic Separation.

Magnetic Separation of Iron Ore in Sweden. G. Walfrid Petersson. Illustrates and describes methods and machines used. Twenty-one plants are in operation, producing concentrates containing 63 to 65 per cent. iron from ore carrying 25 to 30 per cent. 4500 w. Eng & Min Jour—May 11, 1907. No. 84312.

Malleable Iron.

Manufacture of Malleable Iron. G. A. Akerlind. Read before the Scandinavian Tech. Soc., Chicago. A review of the manufacture, physical properties, and treatment. 3000 w. Foundry—May, 1907. No. 84057.

Open Hearth.

A Modern Acid Open Hearth Steel Casting Plant. Illustrated detailed description of the new department of the National Foundry Co., Erie, Pa. 2200 w. Foundry—May, 1907. No. 84056.

Cost of Equipping Open Hearth Steel Foundries. W. M. Carr. Gives an estimate made on the basis of daily capacity. 800 w. Foundry—May, 1907. No. 84059.

Production.

Diagram of the Processes and Products of Iron and Steel Manufacture. Albert Sauveur. Gives a diagram drawn by H. M. Boylston, of Harvard University, outlining the information it yields. 1200 w. Ir Trd Rev—May 9, 1907. No. 84271.

Retort Charging and Discharging Machine. Illustrated description of a machine for use in connection with continuous horizontal retorts having two mouths. 800 w. Engr, Lond—April 19, 1907. No. 84008 A.

Steel Making.

A Method of Producing High-Class Steel from Pig-Iron Containing Chromium, Nickel and Cobalt. Arthur Windsor Richards. Gives a detailed description of the process. 1500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84614 A.

The Manufacture of Steel from High-Silicon Phosphoric Pig-Iron by the Basic Bessemer Process. Arthur Windsor Richards. Describes the process in use at the Cleveland Works for blowing in the basic converter iron which is high in silicon and low in phosphorus. 1500 w. Ir & Coal Trds Rev—May 10, 1907. No. 84613 A.

The Relation Between the Process of Manufacture and Some of the Physical Properties of Steel. F. W. Harbord. Gives tabulated results from experimental bars and other sources, with report of tests. 2200 w. Ir & Coal Trds Rev—May 10, 1907. No. 84615 A.

Würtemberg.

The Iron-Ore Deposits and Iron Industry in Würtemberg (Die Eisenerzlagerstätten und die Eisenindustrie Würtembergs). C. Geiger. Information compiled from the Würtemberg Statistical Annual. Map. 2800 w. Stahl u Eisen—April 24, 1907. No. 84131 D.

MINING.

Air Compressors.

Portable Electric Air Compressors. Frank C. Perkins. Illustrated description of machines used to obtain the advantages of electric transmission and of compressed air operation for mining machinery. 1200 w. Mines & Min—May, 1907. No. 84064 C.

Bore-Holes.

Camera for Photographing Walls of Bore-Holes. J. T. Atwood. Illustrated description of a camera and the method of operation, for obtaining views of a continuous strip of the formations pierced by the drill, showing the character and distribution of the ore. 1500 w. Eng & Min Jour—May 18, 1907. No. 84420.

Car Handling.

Handling Cars with Rolling Device for Dumping. Erskine Ramsay. Illustrates and describes a car-handling and dumping device used at many American mines, stating its advantages. 1500 w. Eng & Min Jour—May 11, 1907. No. 84317.

Compressed Air.

Compressed Air in Mining. J. H. Hart. Remarks on the efficiency and economy of falling-water compressors, explaining their operation. 900 w. Eng & Min Jour—May 4, 1907. No. 84218.

Drainage Tunnel.

The Cripple Creek Drainage Tunnel and Its Significance in Scientific Mining. Victor C. Alderson. Abstract of an address delivered at the inauguration of the driving of the deep drain tunnel. 3300 w. Min Rept—May 16, 1907. No. 84410.

Examination.

The Examination of Mining Properties (Die Begutachtung von Bergwerksunternehmungen). Otto Pütz. Discusses the various factors which should enter into a decision of the value of a mining property. 2300 w. Glückauf—April 27, 1907. No. 84154 D.

Grinding Machines.

Machines for Grinding Chalk, Cements, Phosphates and Similar Materials (Appareils de Broyage pour Chaux, Ciments, Phosphates et Matières Analogues). P.

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Chignaterie. Illustrated description of various types with plate showing sections of mills. 3000 w. Génie Civil—April 20, 1907. No. 84116 D.

Mine Locomotives.

The Prevention of the Risk of Fire in the Use of Benzol Mine Locomotives (Die Verhütung der Brandgefahr bei Benzol Grubenlokomotiven). Herr Russell. Illustrates and describes this type of locomotive and safe ways of storing and using benzol underground in coal mines. 2000 w. Glückauf—April 27, 1906. No. 84153 D.

Mine Timber.

Preservation of Mine Timber. John M. Nelson. Gives conclusions from experimental work, with various methods of treatment and the cost. Ills. 1200 w. Min Wld—May 25, 1907. No. 84604.

The Preservation of Mine Timber from Decay. An account of experiments made with different preservatives and different methods of applying, with a comparison of costs. Ills. 1200 w. Mines & Min—May, 1907. No. 84066 C.

Montana.

Annual Address. Bertram H. Dunshee. Presidential address, considering recent improvements in the mining and treatment of ores, especially in Montana. 9000 w. Jour Assn of Engng Socs—April, 1907. No. 84526 C.

Ore Deposition.

Effect of Wall Rock on the Deposition of Ore. G. W. Miller. Observations on the geology of the metal-bearing veins of Silver Mountain and vicinity in the San Juan region of Colorado. 1700 w. Ores & Metals—May 20, 1907. No. 84452.

Philippines.

Mines and Minerals in the Philippines. Thornton Chase. A report of rich deposits of coal, iron, copper, lead and gold. 1200 w. Eng & Min Jour—May 4, 1907. No. 84217.

Power Plant.

The Electrical Equipment of the Yak Tunnel. Robert E. Renz. Illustrates and describes the plant which supplies current for the operation of the tunnel, for mining in adjoining properties, and for lighting and power. 2000 w. Eng & Min Jour—May 25, 1907. No. 84570.

Prospecting.

Prospecting in Ungava. J. C. Murray. Begins an illustrated description of this portion of the Labrador peninsula. 1800 w. Serial. 1st part. Can Min Jour—May 1, 1907. No. 84086.

Pumping.

Mine Pumping with Direct Connected Electrically Driven Turbine Pumps. P. H. Moore. Read before the Nova Scotia Min. Soc. An account of the writer's experience with turbines in the Micmac Mines, Nova Scotia, describing the plant. 2800 w. Can Min Jour—May 1, 1907. No. 84088.

Safety Lamp.

The Wolf Safety Lamp. L. H. Hodgson. Illustrates and describes this lamp, showing its efficiency. 1000 w. Eng & Min Jour—May 18, 1907. No. 84424.

Shafts.

Sinking the Allan Shafts. H. E. Coll. Read before the Nova Scotia Min. Soc. Describes the equipment, sinking operations, method of timbering, etc. 3800 w. Can Min Jour—May 1, 1907. No. 84084.

South America.

Colombia; Its Resources and Its Development. J. T. O'Brian. Information gathered during several years of research. Reports fertile lands, favorable climate, inexhaustible forests, mining prospects of promise, great natural wealth almost undeveloped. 2500 w. Min Wld—May 25, 1907. No. 84605.

Stoping.

Stoping Systems at Broken Hill, Australia. A. J. Moore. Illustrates and describes methods devised to meet the conditions encountered in mining large bodies of sulphide ores. 4200 w. Mines & Min—May, 1907. No. 84061 C.

Subsidence.

Mine Subsidence. Alex. Richardson. Gives conclusions reached from a study of the surface effects of subsidence, giving diagrams showing the caving of various mines, discussing methods of protection and the subject in general. 4200 w. Jour Chem, Met & Min Soc of S Africa—March, 1907. No. 84433 E.

MISCELLANY.

Asbestos.

Asbestos. An illustrated article discussing the commercial aspects and giving general information of the asbestos industry. Also The Canadian Asbestos. Fritz Cirkel. A review of progress. Ills. 3000 w. Can Min Jour—May 15, 1907. No. 84400.

Cobalt.

Cobalt: Its Occurrence and Uses. Joseph Hyde Pratt. Information concerning this mineral and its uses, and localities in North Carolina where it has been found. 1500 w. Min Wld—May 4, 1907. No. 84235.

Graphite.

Canadian Graphite. H. P. H. Brunnell. Abstract of a paper read before the Can. Min. Inst. Gives information concerning the ore deposits, milling, etc. 1200 w. Min Wld—May 18, 1907. No. 84412.

Separating Graphite on Molybdenite. James Francis Latimer. An account of an invention for an improved process for separating and refining of graphite from graphite material, and molybdenite and

other minerals from their gangue. Ill. 1500 w. Min Wld—May 18, 1907. No. 84413.

Illinois.

The Work of the State Geological Survey. H. Foster Bain. An account of what has been done, and the work proposed, in the geological survey of Illinois. Map. Discussion. 7000 w. Jour W Soc of Engrs—April, 1907. No. 84531 D.

Lead.

A Curious Deposit of Cerussite in Colorado. Robert B. Brinsmade. Describes an unusual deposit in the Terrible Mine, at Ilse, Custer Co. It is not associated with sulphides and other minerals usually found with lead. 1200 w. Eng & Min Jour—May 4, 1907. No. 84215.

Lead Refining.

See Electrical Engineering, Electro-Chemistry.

Mercury.

Electro Determination of Mercury and Its Separation from Silver. Henry Julius Solomon Sand. Abstract of a paper from *Jour. of Chem. Soc.*, London. Describes experimental investigations. 1000 w. Min Rept—April 25, 1907. No. 84017.

Ore-Dressing.

Developments in Ore-Dressing (Fortschritte in der Erzaufbereitung). Ulrich Horel. Illustrated description of several of the latest ore-dressing tables. 2500 w. Oest Zeitschr f Berg und Hüttenwesen—April 20, 1907. No. 84135 D.

Petroleum.

Petroleum and Its Refinement. Prof. Charles E. Munroe. An illustrated account of this product and the methods used for its purification and refinement. 6000 w. Sci Am Sup—May 4, 1907. No. 84083.

Phosphate.

Phosphate Rock in Utah, Idaho, and Wyoming. Charles Colcock Jones. Describes these deposits. Ills. 2000 w. Eng & Min Jour—May 18, 1907. No. 84422.

Sodium Nitrate.

The Sodium Nitrate Deposits of the Colorado. H. W. Turner. Describes these deposits, reporting examinations made in four localities. Map. 1200 w. Min & Sci Pr—May 18, 1907. No. 84601.

Sulphur.

Determination of Sulphur in Pyrite. Henry Fay. Describes the methods of Lunge, and of Fresenius, with notes. 2200 w. Tech Qr—March, 1907. No. 84472 E.

Tin.

The Tin-Mining Industry of Cornwall. Illustrated description of the mining and treatment of the ore, the revival of the industry, and improved methods. 2200 w. Sci Am Sup—May 4, 1907. No. 84082.

The Tin-Stream Works of Red River, Cornwall. Edward Walker. Explains the treatment of tailings over and over again by twelve to twenty operators. Ills. 1200 w. Eng & Min Jour—May 25, 1907. No. 84571.

Tin Ore Dressing. J. B. Hill and D. A. MacAlister. Illustrates and describes the more important appliances actually in use in the mines of the Camborne district in West Cornwall, England. 1200 w. Min Wld—May 11, 1907. Serial. 1st part. No. 84309.

Tin Ore Dressing Plant, East Pool, Cornwall. Edward Walker. Illustrates and describes the reconstructed Tolvadden ore-dressing plant where tin oxide, wolframite, arsenical and copper pyrites are separated by stamps, concentrating tables, calciners and magnetic separators. 1500 w. Eng & Min Jour—May 18, 1907. No. 84419.

The Smelting of Tin Slags. L. Parry. Explains the principles underlying the cleaning of tin slags, the recovery of the tin, especially a lead concentration process patented by the writer. 3000 w. Min Jour—April 27, 1907. No. 84250 A.

Tungsten.

The Panasqueira Tungsten District, Portugal. Wilhelm Preus. Describes the location, mineralization, etc. Map. 800 w. Eng & Min Jour—May 4, 1907. No. 84214.

The Tungsten Deposits of Boulder County, Colo. William E. Greenawalt. Describes an old gold and silver camp which now produces more than 80 per cent. of the tungsten of the United States. 1500 w. Eng & Min Jour—May 18, 1907. No. 84421.

The Rare Minerals: Their Present Industrial Status. Edgar C. Riebe. Discusses principally the tungsten minerals, their uses, and the reasons for their slow development in the United States. 1200 w. Min Wld—May 4, 1907. No. 84236.

Underground Waters.

The Geological Relations of Water in the Graner Lignite Deposits (Die Wasserverhältnisse des Graner Braunkohlenreviers). Karl Stegl. The first instalment describes the floods which have occurred during the last thirty years in the mines of this Austrian coal field. Ills. 3000 w. Serial. 1st part. Oest Zeitschr f Berg und Hüttenwessen—April 13, 1907. No. 84134 D.

Volumetric Methods.

On Technical Volumetric Methods in General. V. H. Gottschalk. Read before the W. Assn. of Tech. Chem & Met. Discusses the nature of the chemical reaction employed; the nature of the indicator; dependence on conditions of titration; and proper manipulation of measuring instruments. 5000 w. Min Jour—May 18, 1907. No. 84576 A.

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Zinc.

Production and Consumption of Spelter in 1906. Walter Renton Ingalls. Statistics of production and consumption of spelter and zinc ore. Ills. 3400 w. Eng & Min Jour—May 18, 1907. No. 84418.

Broken Hill Zinc Field, New South Wales. Ralph Stokes. Concerning the treatment by the Delprat process of the tailings from the Barrier ores, which are rich in zinc. Also the treatment of old tailings at the Central Mine by the magnetic method. Ills. 1500 w. Min Wld—May 4, 1907. No. 84233.

Zinc Oxide.

Zinc-Oxide and Zinc-Lead Pigment Manufacture. William F. Gordon. An illustrated article explaining how the process requiring pure zinc ores and anthracite fuel was made suitable for complex ores and the use of soft-coal and for saving the copper, gold and silver. 1400 w. Eng & Min Jour—June 1, 1907. No. 84705.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Government Accident Bulletin, No. 22. The report of the Interstate Commerce Commission for the three months ending Dec. 31, 1906. Also the the Virginia Commission report on the Lawyer collision. 4500 w. R R Gaz—May 24, 1907. No. 84539.

Derailment.

The Bronx Park Derailment on the New York Central: Report of the State Railroad Commission. Gives the findings and recommendations of this commission, with comments. 2000 w. Eng News—May 16, 1907. No. 84388.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Control on Heavy Grades of Trains Composed Exclusively of Fully Loaded 100,000 Lbs. Capacity Cars. T. L. Burton. From a paper read before the Air Brake Assn. Reports tests made which proved the ability of air brakes used exclusively to control a heavy train under severe conditions. 1000 w. R R Gaz—May 24, 1907. No. 84543.

S F 4, Pump Governor. Discusses some of the peculiarities in the operation of this pump governor which is designed to automatically adjust the relation of the brake pipe and the main reservoir pressure. 7000 w. Ry & Loc Engng—May, 1907. No. 84031 C.

Cars.

Combination Parlor, Sleeping and Dining Cars for the Canadian Northern. Illustrated description of the general arrangements and finish of these cars. 500 w. R R Gaz—May 3, 1907. No. 84079.

Dynamometer.

Portable Traction Dynamometer. E. N. Stacey and O. B. Bjorge. Illustrates and describes a dynamometer designed to measure tractive effort. 800 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84628 N.

Freight Cars.

Maintenance and Repair of Steel Freight Cars. An illustrated article considering the life of steel cars, their repair, liability to damage, their design, cost, etc., as reported by the Baltimore & Ohio Railroad. 10000 w. Am Engr & R R Jour—May, 1907. No. 84092 C.

Composite Hopper Car. Illustrated description of cars of 85,000 lbs. capacity for the Delaware & Hudson Company. 700 w. Am Engr & RR Jour—May, 1907. No. 84095 C.

Historical Address.

Address by the President, T. Hurry Riches. Brief discussion of railway rolling stock, and machinery. Many illustrations. 4000 w. Inst of Mech Engrs—April 25, 1907. No. 84478 N.

Locomotives.

The Modern Locomotive. Paul T. Warner. Discusses the features of modern locomotives which have made possible the meeting of present day demands, giving brief illustrated descriptions of some of the engines. 6000 w. Jour Fr Inst—May 1, 1907. No. 84551 D.

An Interesting Order of Locomotives. Illustrates and describes the ten locomotives for the Central Railroad of Brazil. Six are of the consolidation type, two of which are equipped with Baldwin superheaters; two are single expansion 10-wheel locomotives fitted with Vaughan superheaters, and two are 10-wheel type with balanced compound cylinders. 1400 w. Ry Mas Mech—May, 1907. No. 84269.

Petrol Electric (Mixed Traction) Locomotive on the Belgian State Railways for Shunting Goods Wagons. Em. Uylborck.

We supply copies of these articles. See page 687.

An illustrated description of the mixed traction locomotive on the Pieper system. Its principal components are an internal combustion engine, a continuous-current dynamo, and a battery of accumulators. 3000 w. Bul Int Ry Cong—April, 1907. No. 84521 E.

An Italian Balanced-Compound Passenger Locomotive with Cab in Front. Illustrates and describes a peculiar design introduced extensively on the Adriatic lines of the Italian State Rys., with report of service. 1500 w. Eng News—May 23, 1907. No. 84498.

Italian Balanced Compound Locomotive. Illustrated detailed description of a high-powered "Prairie" type engine for fast passenger trains. 1500 w. Engr, Lond—April 19, 1907. No. 84006 A.

Compound Locomotive, St. Gothard Railway. Illustrated description of an engine recently built for the most difficult service on this line. 700 w. Engr, Lond—May 17, 1907. No. 84584 A.

Standard Locomotives of the Midland Railway. Illustrates four of the standard freight and passenger locomotives in use on this English railway, giving descriptions and tractive power. 1200 w. R R Gaz—May 24, 1907. No. 84541.

Simple Consolidation Locomotive. Illustrated description of heavy single expansion freight engines built for the Colorado Southern, New Orleans and Pacific Railroad. 800 w. Am Engr & R R Jour—May, 1907. No. 84096 C.

Decapod Locomotive for the Buffalo, Rochester & Pittsburg. Elevation, sections, and description of the heaviest simple engines ever built for pushing service. 900 w. Ry Age—May 10, 1907. No. 84285.

Four-Cylinder Simple Ten Wheel Locomotive. Charles S. Lake. Illustrates and describes a type of powerful high speed locomotives in service on the London & Southwestern Railway. 2000 w. Am Engr & R R Jour—May, 1907. No. 84094 C.

The Four Cylinder Balanced Compound in Actual Service. H. A. F. Campbell. Presents records made by 4-cylinder balanced compound Atlantic locomotives in actual service. 4000 w. Ry Mas Mech—May, 1907. No. 84266.

High-Power Articulated Locomotives in the United States (L'Emploi de Locomotives Articulées de Grande Puissance aux Etats-Unis). M. Japiot. Describes the Mallet locomotives in use on the Baltimore & Ohio, Great Northern, and Erie Railroads. Ill. 6000 w. Rev Gén des Chemins de Fer—April, 1907. No. 84-110 G.

Road Performance of Mallet Compound Locomotives. A report of these engines for helper service on the mountain divisions of the Great Northern Railroad. 800 w. Ry Mas Mech—May, 1907. No. 84267.

Rack Locomotive for the Trans-Andine Railway. Describes the line on which these engines are to be used, and gives an illustrated description of the locomotives. Plate. 1500 w. Engng—May 17, 1907. No. 84578 A.

Locomotive Tests.

Analysis of Locomotive Tests. Sidney A. Reeve. Gives analyses made to ascertain what proportions of heat developed within a locomotive boiler were absorbed by the earlier and later portions of the heating surface, or by fire-box and tubes, or were lost up the stack. The St. Louis tests formed the basis for the investigation. 1200 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84643 F.

Locomotive Performance Data Developed at Purdue. Editorial review of valuable information obtained from this testing plant. 1700 w. R R Gaz—May 3, 1907. No. 84073.

Motor Cars.

European Railway Motor Cars. B. D. Gray. Illustrates and describes types of self-propelled cars used abroad, and gives the author's impressions of the railway motor car situation. 5400 w. Pro Am Soc of Mech Engrs—June, 1907. No. 84642 F.

Gasoline Motor Cars for Railway Service. W. R. McKeen, Jr. Discusses the design of such cars, the engine, cost of operation, etc. General discussion. Ills. 14500 w. Pro N Y R R Club—April 19, 1907. No. 84482.

Pennsylvania Report on Motor Cars. Extracts from report of a special committee appointed to study the operation of foreign road and rail motor cars. 3500 w. R R Gaz—May 3, 1907. No. 84075.

Stokers.

Mechanical Stokers for Locomotives. George S. Fowler. States the requirements of such stokers, and gives plans and description of the Victor stoker and the Hayden stoker. 3000 w. Cassier's Mag—May, 1907. No. 84054 B.

Superheated Steam.

See Mechanical Engineering, Steam Engineering.

Train Lighting.

Electric Train Lighting. O. W. Ott. Discusses briefly the three principal systems on the lighting of trains by electricity, the cost, maintenance, etc. General discussion. 11500 w. Pro W Ry Club—April 16, 1907. No. 84484 C.

Vibrations in Passenger Trains from High Speed Electric Lighting Engines. F. W. Huels. Gives results of tests made to measure the magnitude and character of these vibrations, describing methods and instruments used. Discussion. Ills.

7000 w. Jour W Soc of Engrs—April, 1907. No. 84530 D.

Car Lighting. Ed. Wilhelm. Principally an explanation of the advantages of Pintsch gas. General discussion. 3000 w. Pro Iowa Ry Club—April 12, 1907. No. 84481 C.

Valves.

Locomotive Piston Valves. Hal R. Stafford. Gives a brief account of the earlier applications of the piston valve to the locomotive, and discusses their advantages and disadvantages. Ills. 3000 w. Am Engr & R R Jour—May, 1907. No. 84093 C.

NEW PROJECTS.

Chicago.

Improvements on the Chicago Division of the Cleveland, Cincinnati, Chicago & St. Louis Ry. Maps, profiles, and descriptive account of extensive improvements, including various kinds of work. Also editorial. 6000 w. Eng News—May 16, 1907. No. 84386.

Florida.

Construction of Florida East Coast Railway. Allen Hale. Illustrates and describes interesting phases of this remarkable railroad. 1500 w. Sci Am—May 18, 1907. No. 84392.

N. Y. C. & H. R. R. R.

New York Central & Hudson River. Discusses the improvements made during 1906 and 7, the electrification, improved stations, increase in earnings and related matters. 1800 w. R R Gaz—May 3, 1907. No. 84074.

Oregon.

Line Changes and Extensions of the Oregon Railroad & Navigation Company's System in Oregon and Washington. W. P. Hardesty. An illustrated account of work recently completed, still under way or authorized. 3500 w. Eng News—May 16, 1907. No. 84384.

Providence.

New York, New Haven & Hartford Improvement at Providence. An illustrated description of the construction of a tunnel under the hill upon which Providence, R. I., is situated, and a bridge across the Seekonk river. 2000 w. Ry Age—May 3, 1907. No. 84099.

PERMANENT WAY AND BUILDINGS.

Construction.

Construction and Maintenance of Way. W. H. Hoyt. Discusses the important features of construction and maintenance of roadway and improvements in track construction. 2500 w. Engrs' Soc of Univ of Minn—Year Book, 1907. No. 84630 N.

Permanent Way; Its Construction and Maintenance. Arthur John Grinling. Discusses the details and construction of permanent way, the keeping of the line in repair and the renewal of defective and worn-out material. 4200 w. Inst of Civ Engrs, No. 555—No. 84458 N.

Curves.

Setting Out Curves. Thomas G. Bocking. Gives a simple rule and a table of tangential angles calculated upon it. 800 w. Engr, Lond—May 17, 1907. No. 84583 A.

Grades.

Value of Grade Reductions. William G. Raymond. Gives a statement of the problem and three methods of determining the result. 1000 w. R R Gaz—May 3, 1907. No. 84077.

Gravity Yard.

The Rutherford Gravity Yard of the Philadelphia & Reading Ry. Illustrated description of the new terminal yard, about five miles east of Harrisburg, Pa. 1500 w. Eng Rec—May 4, 1907. No. 84222.

Interlocking.

Electric Locking. W. H. Arkenburgh. An illustrated description of the electric locking system and its operation. 4000 w. R R Gaz—May 3, 1907. No. 84076.

Rails.

Breakages of Steel Rails. Robert Job. An illustrated article discussing some of the defects in steel rails, and the manner in which they may be discovered by inspection, and prevented in the course of manufacture. 3000 w. Cassier's Mag—May, 1907. No. 84053 B.

The Peril of the "Broken Rail"—Its Cause and Cure. Reports results of an investigation recently made by the editor, giving a statement of past and present conditions of rail making, and concluding that it is necessary to abandon the Bessemer process and adopt the Open Hearth process and return to slower methods of manufacture. Ills. 2500 w. Sci Am—May 18, 1907. No. 84391.

Defective Rails. A collection of unsigned letters concerning the quality of the rails furnished by the steel companies, with editorial comment. Ills. 6500 w. R R Gaz—May 17, 1907. No. 84382.

Note on the Wear of Rails. Léon de Lubimoff. Aims to determine what relation exists between the hardness of rail steel and its mechanical properties. Ills. 3800 w. Bul Int Ry Cong—April, 1907. No. 84522 E.

Proposed Use of Vanadium in Rail Metal. B. de Alzuaray, in the New York *Commercial*. Discusses the causes of rail breakage and the proposed remedies, advocating the introduction into the manufacture of steel of a suitable portion of ferro-vanadium alloy. 700 w. Ry & Engng Rev—May 18, 1907. No. 84398.

We supply copies of these articles. See page 687.

Rail Fractures on Railways in New York State. Information from a bulletin of the New York State Railroad Commission showing the total number of rail breaks on the principal steam railways of the state during the winter months, January to March, of the last three years. 900 w. Eng News—May 2, 1907. No. 84045.

Sand Blast.

Railroad Sandcraft. J. M. Betton. On the application of the sand blast to railroad service. 3300 w. Compressed Air—April, 1907. No. 84534.

Shops.

Locomotive Shops at Trenton. An illustrated detailed description of the shops of the Pennsylvania Railroad. 1800 w. Ry Mas Mech—May, 1907. Serial. 1st part. No. 84268.

Signaling.

A New System of Block Signaling on the Pennsylvania R. R. Gives an abstract of a descriptive statement in regard to the new system now in experimental service. Also editorial. Ills. 7000 w. Eng News—May 9, 1907. No. 84292.

Course for Apprentices in Signal Engineering. Information relating to the terms of employment of the Union Switch & Signal Co., with editorial comment. 1200 w. Ry & Engng Rev—May 18, 1907. No. 84399.

Prussian State Railway Signals. W. H. Pockels. Illustrates and describes the signals used. 1000 w. R R Gaz—May 24, 1907. No. 84540.

Station.

Proposed New Union Station at Toronto. Illustrated description of a station for use of the Grand Trunk and the Canadian Pacific railways. 1800 w. R R Gaz—May 24, 1907. No. 84542.

Terminals.

Freight Terminal of the Central of New Jersey in the Bronx. Plans and description of the method employed to utilize every available square foot of the restricted ground secured in the vicinity of New York City. 1200 w. Ry Age—May 10, 1907. No. 84284.

The Delaware, Lackawanna and Western Railroad Terminal and Ferry-House at Hoboken, N. J. Kenneth M. Murchison. Illustrated detailed description of this new fireproof structure and its many interesting engineering features. 2000 w. Archts & Builds' Mag—May, 1907. No. 84355 C.

The Greenville Terminal of the Pennsylvania R. R. Plan and description of a terminal for freight service under construction just south of Jersey City. 2500 w. Eng Rec—May 11, 1907. No. 84320.

The Hudson Tunnels and Their Terminals. An illustrated article giving interesting information in regard to these tunnels and terminals. 1000 w. Archts & Builds' Mag—May, 1907. No. 84356 C.

Track Elevation.

The 16th St. Track Elevation of the Burlington at Chicago. Illustrates and describes the elevation of 2.4 miles of track in a very busy section, with construction of additional tracks and other new features. 1800 w. R R Gaz—May 10, 1907. No. 84286.

Tracks.

On the Economic Renewal and Maintenance of Railway Tracks for High Speed Traffic. L. Schlüssel. An account of the examination of a Vignoles track, with cramps, wedges, and shock-absorber or deadener blocks. Ills. 12700 w. Bul Int Ry Cong—April, 1907. No. 84520 E.

Yards.

Southern Railway Freight Yard at Atlanta, Ga. Plan and illustrated description of a one-hump yard arrangement. 1000 w. Ry Age—May 17, 1907. No. 84397.

TRAFFIC.

Car Handling.

Delay in Movement of Empty Cars at Terminals. W. E. Beecham. Discusses briefly methods of handling empty cars, especially referring to Chicago, with committee report and discussion of the rules of interchange. 8000 w. Pro W Ry Club—April 16, 1907. No. 84483 C.

The Movement of Freight Cars on American Railways. Abstracts of several recent papers on this subject, with editorial. 12000 w. Eng News—May 23, 1907. No. 84495.

Freight.

Comparative Summary of Freight Cars in Service on the Railroads of the United States. Table prepared from data contained in the annual reports of most railroads of the United States operating over 500 miles, with comments. 1800 w. R R Gaz—May 17, 1907. No. 84383.

Freight Handling at the Port of New York. From an article by William S. Root, in *Railroad Men*. An explanation of conditions at this port and the facilities provided for the expeditious handling of freight. 1700 w. R R Gaz—May 3, 1907. No. 84078.

MISCELLANY.

American Railways.

After Seven Years. H. Perry Robinson. The first of a series of articles giving some impressions of American railways after long residence abroad. 1600 w. Ry Age—May 10, 1907. Serial. 1st part. No. 84283.

India.

The Railways of British India. A brief review of the progress of Indian railways.

We supply copies of these articles. See page 687.

2200 w. Engr, Lond—April 26, 1907. No. 84259 A.

New England.

A New England Railroad Situation. An interesting editorial on the present aspects of leading New England lines and the recent changes. 1200 w. R R Gaz —May 3, 1907. No. 84072.

Regulation.

Objects and Effects of State Regulation. From an address by W. W. Finley. A discussion of recent state legislation, quoting opinions of Mr. Knapp, of the Interstate Commerce Commission, and matters bearing on this subject. 2300 w. R R Gaz —May 10, 1907. No. 84289.

Resistance.

A Discussion of Train Resistance. A short summary of a report made by a Committee of the Am. Ry. Engng. & Main. of Way Assn., indicating the character of the information obtained and the deductions drawn. 4200 w. Eng Rec —May 25, 1907. No. 84563.

STREET AND ELECTRIC RAILWAYS

Accounting.

Accounting of Depreciation by Electric Railways. Robert N. Wallis. Discusses methods used and matters to be considered in electric railway accounting. 2200 w. Jour of Acc—May, 1907. No. 84552 C.

Brooklyn, N. Y.

The Rehabilitation of the Brooklyn Rapid Transit Company. The first of two articles outlining the reasons for the public hostility toward this company, and considering in detail the efforts being made to give real rapid transit under very hard conditions. Also editorial. Maps. 5500 w. R R Gaz—May 10, 1907. Serial. 1st part. No. 84287.

The Brighton Beach Improvement of the Brooklyn Heights Railroad. Illustrated description of extensive changes in progress on the line to Coney Island. 1800 w. St Ry Jour—May 11, 1907. No. 84282.

Buenos Aires.

The Street Railways of Buenos Aires, Argentina. Gives the most recent statistics in regard to immense traffic on these lines, the style of cars in use, the various types of construction and other data of interest. Ills. 3000 w. St Ry Jour—June 1, 1907. No. 84685.

Couplers.

Standard M. C. B. Couplers for Interurban Cars. Brief illustrated description of the type of coupler used by the Pacific Elec. Ry., Los Angeles, Cal., which is capable of intercoupling with all rolling stock of that or any other system. 700 w. Elec Ry Rev—May 18, 1907. No. 84402.

Dispatching.

Combined Telegraph and Telephone System Used by the Interurban Railway, Des Moines. Describes a composite system having features of interest for interurban lines, and greatly diminishes the likelihood of a total interruption. 2000 w. St Ry Jour—May 18, 1907. No. 84373.

Fire Protection.

The System of Fire Protection at the Plank Road Shops of the Public Service Corporation of New Jersey. Martin Schreiber. Describes briefly some features of construction and the practice of the company in handling and storing material; and gives an illustrated description of the system of fire protection installed. 5000 w. St Ry Jour—June 1, 1907. No. 84684.

Freight.

Freight Handling at Birmingham, Ala. Gives billing and other forms used to facilitate the handling of shipment in the service between the city and suburban districts. 1000 w. Elec Ry Rev—May 18, 1907. No. 84403.

Interurban.

An Indian Territory Interurban System. Illustrated description of the line of the Choctaw Railway & Light Co., extending from South McAlester to Hartshorne. 1500 w. St Ry Jour—May 25, 1907. No. 84569.

Construction of the Lafayette & Logansport Railway. R. M. Feustel. Illustrated description of an interurban line in Indiana for high-speed service. 2000 w. Elec Ry Rev—May 4, 1907. No. 84205.

Operating Features of the Boston & Worcester Street Railway. An illustrated article fully describing the operative features and giving a schedule of the cost of power generation and operation. 10000 w. St Ry Jour—May 4, 1907. No. 84228.

The Ft. Dodge, Des Moines and Southern Railway. Illustrated description of this line, partly on private right of way, and partly on electrified old lines. 1700 w. Elec Ry Rev—May 25, 1907. No. 84599.

Layouts.

A Graphic Method of Determining Tie-Rod Spacing in Track Layouts. Claude W. L. Filkins. Gives a chart with directions for use and an explanation of the underlying principles. 800 w. St Ry Jour—June 1, 1907. No. 84686.

We supply copies of these articles. See page 687.

Lausanne.

Lausanne Tramways (Les Tramways Lausannois). M. E. Barraud. Notes on recent extensions in the network of interurban electric railways radiating from Lausanne, Switzerland, giving details of construction, operation, traffic, etc. Ills. 2500 w. Bull Tech Suisse Rom—April 25, 1907. No. 84111 D.

London.

City and South London Railway. Map, plans and description of the Islington to Euston extension. 3300 w. Tram & Ry Wld—May 2, 1907. No. 84352 B.

Mono-Rail.

A New Mono-Railway. Illustration with brief description of the mono-railway designed by Louis Brennan, and report of trials. 1000 w. Engr, Lond—May 10, 1907. No. 84450 A.

N. Y. Subway.

The Air of the New York Subway Prior to 1906. George A. Soper. Record of facts concerning the quality of the air of the subway before any change was made in the ventilating arrangements, with explanation of the conditions. Ills. 15000 w. Tech Qr—March, 1907. No. 84473 E.

Rail Corrugation.

The Causes of Rail Corrugation. Describes tests made by H. B. Nichols, and the apparatus used, which seems to prove the trouble to be due to vibration, either in the rails or in the entire track structure. Ills. 1500 w. Tram & Ry Wld—May 2, 1907. No. 84354 B.

Rail Corrugations in Philadelphia. Points out differences in practice in the street railways of England and America, and describes the conditions in Philadelphia and gives H. B. Nichols' conclusion that rail corrugations are caused by vibrating rails. Ills. 2000 w. St Ry Jour—May 18, 1907. No. 84372.

Rails.

New Rails for the Chicago Street Railways. Gives specifications for rails of the grooved girder type. 1500 w. Eng News—May 23, 1907. No. 84497.

Single-Phase.

Single-Phase Electric Traction. Charles Frewen Jenkin. Shows the progress made in other systems, and describes some of the more important apparatus and appliances used for single-phase traction, discussing the problems which arise in their working. Also discussion. Plates. 25000 w. Inst of Civ Engrs, No. 3647. No. 84469 N.

Single-Phase Railways. F. E. Wynne. An illustrated article describing in detail the single-phase system and its operation. General discussion. 9000 w. Pro Engrs' Club of Phila—April, 1907. No. 84524 D.

The Peoria-Bloomington Single-Phase Line. A road built on a private right of way 80 ft. wide, in Illinois, is illustrated and described. 1200 w. St Ry Jour—May 4, 1907. No. 84231.

South America.

Tramway System of Montevideo. An illustrated description of the electrically operated lines at the capital of Uruguay. 2500 w. St Ry Jour—May 4, 1907. No. 84230.

Station.

The Power Station of the Little Rock Railway & Electric Company. Illustrated description of a station which departs, in many details, from the usual practice. The notable features are the provisions for light and ventilation, the vertical loop system of the main steam and main feeder headers, and the cylinder lubricating system. 1800 w. St Ry Jour—May 11, 1907. No. 84281.

Terminal System.

An Experimental Test of a Railway Terminal System. A report of the test which was carried out at Coney Island, of the system invented by Neils Poulsen for operating the Brooklyn Bridge terminal. 2800 w. Eng News—May 9, 1907. No. 84297.

Third-Rail.

Proposed 1200-Volt Third-Rail Line in California. Particulars in regard to the California Midland Railroad which is to be operated with 1200-volt direct current, distributed by an under-running third rail. 800 w. Elec Ry Rev—May 4, 1907. No. 84204.

Third Rail Design, Composition and Resistance. E. Goolding. Discusses the drawbacks of the Vignoles or tee rails, and the advisability of using harder rails. 1200 w. Tram & Ry Wld—May 2, 1907. No. 84353 B.

Traffic.

Passenger Traffic in Greater New York. Information concerning the enormous passenger traffic to be provided for in Greater New York, its rapid increase, and the necessity of constantly increasing the facilities. 3500 w. Eng Rec—May 11, 1907. No. 84322.

Trail Cars.

The Successful Operation of Trail Cars in Denver. An illustrated description of the successful method of operation of trailers during the rush hours of traffic. 3000 w. Elec Ry Rev—May 4, 1907. No. 84203.

Wires.

The Supporting of the Trolley Wires on Alternating Current Lines (Aanleg en Constructie van den Werkdraad voor Wisselstroombanen). C. Feldmann. Illustrated description of various methods. 2000 w. De Ingenieur—April 27, 1907. No. 84188 D.

We supply copies of these articles. See page 687.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.

Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* So. Bethlehem, Pa.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Refrigeration. *m.* New York.
Industrial World. *w.* Pittsburg.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron and Steel Trades Journal *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Motor Wagon. *w.* Cleveland, U. S. A.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Review of Reviews. *m.* London & New York.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Technograph. *yr.* Urbana, Ill.
Technology Quarterly. *qr.* Boston, U. S. A.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.